PROJECT MANUAL

PROJECT NAME:

Clarinda Correctional Facility (CCF) Kitchen and Laundry Addition

(Volume 2 of 2) (DIV 21 – DIV 33)

PROJECT ADDRESS:
Clarinda Correctional Facility (CCF)
2000 N. 16th St.
Clarinda, IA, 51632

PROJECT DATE: February 9, 2024

OWNER:
Iowa Department of Administrative Services
109 Southeast 13th Street
Des Moines, Iowa 50319

OWNER PROJECT NUMBER: 9223.00

OWNER REQUEST FOR BID NUMBER: RFB 922300-02

CONSTRUCTION MANAGER:
The Samuels Group
2929 Westown Parkway
Suite 200
West Des Moines, IA
50266

CONSTRUCTION MANAGER PROJECT NUMBER: 7673

ARCHITECT:
Farnsworth Group
14225 University Ave.
Ste 110
Waukee, IA
50263

ARCHITECT PROJECT NUMBER: 0240202.00

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DESIGN CONSULTANTS

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SECTION 00 0107
SEALS PAGE



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SIGNED: Seth V. Sunderman DATE: 2/6/2024

SETH V. SUNDERMAN, P.E. 23468

LICENSE RENEWAL DATE: DEC. 31, 2025

PAGES OR SHEETS COVERED BY THIS SEAL: Section 31, 32 & 33



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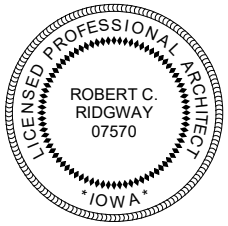
2/6/2024

NATHAN T. KRESS (DATE)

MY LICENSE RENEWAL DATE IS DECEMBER 31, 2025

PAGES OR SHEETS COVERED BY THIS SEAL

014500, 033000, 051200, 052100,
053100, 054000, 055000, 312005



I hereby certify that the portion of this technical submission described below was prepared by me or under my direct personal supervision and responsible charge. I am a duly licensed architect under the laws of the state of Iowa.

Signature: 2/6/2023

ROBERT C. RIDGWAY Date

License Expires: June 30, 2025

Pages or sheets covered by this seal: 02 4100, 03 3511, 03 4500, 04 2000, 05 5100, Div. 6 – 10, 11 1900, 11 1910, 11 1940, 12 3600



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ERIC J. HENDERSON — 02/06/2024

ERIC J. HENDERSON — DATE

MY LICENSE EXPIRATION DATE IS: 12/31/2025

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KRISTEN SPINA — 02/06/2024

KRISTEN SPINA — DATE

MY LICENSE EXPIRATION DATE IS: 12/31/2025

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END OF SECTION

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PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 21 Sections. Also refer to Division 01 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the bid documents and/or Construction Manager's scope statements for complete scope of work description.

D. Scope of Work:

1. Plumbing Work: Refer to Section 22 0500 "Basic Plumbing Requirements".
2. Heating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
3. Air Conditioning and Ventilating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
4. Temperature Control Work: Refer to Section 23 0500 "Basic HVAC Requirements".
5. Fire Protection Work shall include, but is not necessarily limited to:
    a. Extend existing wet pipe sprinkler system for areas noted on the drawings.
    b. Furnish and install all items listed on the Fire Protection Material List.
    c. Furnish all hydraulic calculations and working sprinkler drawings.
    d. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work. Refer to 07 8400.
    e. Complete all applicable tests, certifications, forms, and matrices.
6. Testing, Adjusting, and Balancing Work: Refer to Section 23 0500 "Basic HVAC Requirements".

1.03 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. The Owner reserves the right to determine when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 ALTERNATES

A. Bakery Equipment: Rough-ins are part of Base Bid.

B. Laundry Equipment: Rough-ins are part of Base Bid where noted on the drawings.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
    a. Plumbing Contractor.
    b. Heating Contractor.
    c. Air Conditioning and Ventilating Contractor.
    d. Temperature Control Contractor.

e. Fire Protection Contractor.

f. Testing, Adjusting, and Balancing Contractor.

2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.

3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.

4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.

5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.

   a. This wiring will be from a 120 volt source and may continue as 120 volt or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.

6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.

3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.

4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
    a. Light fixtures.
    b. Gravity flow piping.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:
1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
    a. Burners.
    b. Condensing Units.
    c. Gas Trains.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.

6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    a. Scale of drawings:
        1) General plans: 1/4 Inch = 1 '-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa’s Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:
   1. Secure from the appropriate private or public utility company all applicable requirements.
   2. Comply with all utility company requirements.
   3. Make application for and pay for fire protection water service connection.

F. Examination of Drawings:
   1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
   2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
   3. Scaling of the drawings is not sufficient or accurate for determining these locations.
   4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
   5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
   6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
   7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
   8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
      a. Any item listed as furnished shall also be installed, unless otherwise noted.
      b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:
   1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:
   1. Construction drawings for this project have been prepared utilizing Revit.
   2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
   3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
   4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
   5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
   6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
   7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
   8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
21 05 00	Owner Training Agenda
21 05 29	Hangers and Supports
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment

B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Division of work (e.g., plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor's review stamps
3. Composition:
   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
    a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
    b. Unstamped submittals will be rejected.
    c. The Contractor's review shall include, but not be limited to, verification of the following:
        1) Only approved manufacturers are used.
        2) Addenda items have been incorporated.
        3) Catalog numbers and options match those specified.
        4) Performance data matches that specified.
        5) Electrical characteristics and loads match those specified.
        6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
        7) Dimensions and service clearances are suitable for the intended location.
        8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
        9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
    d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
    e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
    a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
    b. The Contractor shall clearly indicate the size, finish, material, etc.
    c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
    d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions. or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 21 XX XX.description.YYYYMMDD
    b. Transmittal file name: 21 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Coordinate the installation of heavy and large equipment with all contractors and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

C. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.13 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.14 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection

with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Covering exterior walls, interior partitions and chases.
2. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
   a. Pipe wall penetrations are sealed.
   b. Pipe identification is installed.
   c. Branch piping in the location of sprinklers shall be dropped to the ceiling.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.03 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection report by the State Fire Marshal of the fire protection system.
5. Start-up reports on all equipment requiring a factory installation inspection or start-up.

6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.04 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div21.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, one paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.05 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.
5. Description of emergency system operation.

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

F. Minimum hours of instruction for each item shall be:

1. Sprinkler System(s) - 2 hours.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts,

etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.06 SYSTEM STARTING AND ADJUSTING

A. The fire protection systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.07 RECORD DOCUMENTS

A. The following paragraphs supplement Division 01 requirements.

B. Maintain at the job site a separate and complete set of fire protection drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

D. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

E. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

F. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.08 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

B. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

3.09 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Refer to Division 00 and Division 01 specifications for additional requirements which may include special requirements for work within the correctional facility.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. Fire protection system operational.
3. Pipes labeled.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 21 0505
FIRE SUPPRESSION DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fire Suppression Demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.02 PREPARATION

A. Disconnect fire protection systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

3.03 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned piping to source of supply and/or main lines.

C. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

D. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.04 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 21 0529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. FIRE PROTECTION ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.06 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 21 0529
FIRE SUPPRESSION SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.02 QUALITY ASSURANCE

A. Support Sprinkler Piping in conformance with NFPA 13.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 21 0500.

1.04 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to Division 3 Contractor for placement into formwork.

PART 2 - PRODUCTS

2.01 HANGER RODS

A. Hanger rods for single rod hangers supporting steel piping shall conform to the following:

Pipe Size	Rod Size
4" and smaller	3/8"
5" 6", and 8"	1/2"

B. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.02 PIPE HANGERS AND SUPPORTS

A. General:

1. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, -69, -89, and -127 (where applicable).

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, and more frequently when required by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings or lugs. Provide sufficient flexibility to accommodate expansion and contraction without compromising fire barrier penetrations and other fixed takeoff locations.
   a. Products:
      1) Anvil Fig.
      2) CT121
      3) Cooper/B-Line Fig.
      4) B3373CT
      5) Erico Model 510
      6) Nibco/Tolco Fib. 82

2. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.
3. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:
1. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
2. Unless otherwise indicated, hangers shall be as follows:
   a. Clevis Type: Service: Bare Metal Pipe
      1) Products: Bare Steel
         a) Anvil Fig. 260
         b) Cooper/B-Line Fig. 3100
         c) Erico Model 400
         d) Nibco/Tolco Fig. 1.
   b. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller
      1) Products: Bare Steel Pipe
         a) Anvil Fig. 69
         b) Cooper/B-Line Fig. B3170NF
         c) Erico Model FCN
         d) Nibco/Tolco Fig. 200.
3. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
4. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
5. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
   a. Clamp Type: Service: Bare Metal Pipe
      1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
      2) Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.
      3) Products: Bare Steel
         a) Unistrut Fig. P1100 or P2500
         b) Cooper/B-Line Fig. B2000 or B2400
         c) Nibco/Tolco Fig. A-14 or 2STR.

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.)

1) Products:

a) Anvil Fig. 92

b) Cooper/B-Line Fig. B3033/B3034

c) Erico Model 300

d) Nibco/Tolco 68.

b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

1) Products:

a) Anvil Fig. 228, 292

b) Cooper/B-Line Fig. B3054

c) Erico Model 360

d) Nibco/Tolco Fig. 329.

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

1) Products:

a) MCL. M1, M2 or M3

d. Concrete Inserts Single Rod Galvanized:

1) Products:

a) Anvil Fig. 282

b) Cooper/B-Line Fig. B3014

c) Erico Model 355

d) Nibco/Tolco Fig. 310

e. Concrete Inserts Continuous Strip Galvanized:

1) Products:

a) Unistrut Corp P3200 Series

b) Cooper/B-Line Fig. B22-J

c) Erico CONCT

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

g. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

h. Steel Structure Welding:

1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

2.03 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the Division 3 Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.04 PIPE SLEEVES AND LINTELS

A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer's design.

F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

G. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.05 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.

2.06 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.07 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.08 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.01 FIRE SUPPRESSION SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    a. The hanger is attached within 6" from a web/chord joint.
    b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.

3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall in no case exceed the following:
1. Steel (All steel pipe unless otherwise noted):
a. Maximum Spacing:
1) 1-1/4" & under: 12'-0"
2) 1-1/2" & larger: 15'-0"

I. Installation of hangers shall conform to MSS SP-58, -69, -89, and applicable NFPA standards.

END OF SECTION

SECTION 21 1300
FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe, Fittings, Valves, and Connections for Fire Protection System.

B. Wet-Pipe Sprinkler System.

1.02 QUALITY ASSURANCE

A. Welding Materials and Procedures: Conform to ASME Code.

B. Equipment and Components: Bear UL label or marking.

C. Valves: Bear UL label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.

D. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE.

1.03 SUBMITTALS

A. Submit shop drawings per Section 21 0500. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.

B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.

C. Submit detailed working drawings and obtain review of them in the following order:

1. Engineer/Architect
2. State Fire Marshal/Authority Having Jurisdiction
3. Architect/Engineer

D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.

E. Provide the Owner with one copy of NFPA 25. Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.

1.04 EXTRA STOCK

A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store valves and sprinklers in shipping containers, with labels in place.

B. Provide temporary protective coating on iron and steel valves.

C. Maintain temporary end caps and closures in place until installation.

1.06 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves to Division 3 Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

1.07 SYSTEM DESCRIPTION

A. Contractor shall design and install the following water-based fire protection systems for the areas noted on the contract documents:

1. Wet pipe sprinkler system(s)

B. Sprinkler systems shall be designed and installed according to the following standard(s):

1. NFPA 13 - Standard for the Installation of Sprinkler Systems

C. System design and installation shall include all requirements by the Authority Having Jurisdiction, local and state building codes in addition to the previously listed design standard(s). Those requirements shall take precedence over the contract documents in the case of discrepancies.

D. Systems shall be hydraulically calculated in accordance with the applicable design standard(s). Contractor is responsible for final pipe sizing based on results from hydraulic calculations. Pipe sizing shown on drawings for service entrance and main risers is preliminary and for coordination purposes only.

E. The water supply source for this project is the following:

1. Private waterworks system with fire pump.
2. Contractor shall determine the flow and pressure available. For reference, there were several hydraulic system tags on wall near fire pump. They indicated around 60 psi at base of the riser with flow rates around 300 gpm.
3. System design shall provide a safety factor when comparing available water supply pressure versus system design pressure at design flow rate (including hose streams). The safety factor shall be the following:
    a. 5 psig

1.08 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 21 0500 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

1.10 JOB CONDITIONS

A. Fire Protection Contractor shall determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS

A. Piping - 2" and Under (Steel Pipe):

1. Design Pressure: 175 psig
2. Pipe: Schedule 40, black steel, ASTM A53, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3.
4. Fittings:
    a. Threaded:
        1) Cast iron, Class 125, black, UL, ANSI/ASME B16.4.
        2) Malleable iron, Class 150, black, UL, ANSI/ASME B16.3.
        3) Ductile iron, Class 150, black, UL, ANSI/ASME B16.3.
    b. Grooved:
        1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
    c. Flanged:
        1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1.

5. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.

B. Piping - 2-1/2" and Above (Steel Pipe):

1. Design Pressure: 175 psig
2. Pipe: Schedule 10, black steel, ASTM A135, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Fittings:
   a. Grooved:
      1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
   b. Flanged:
      1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1.

2.02 FLEXIBLE FIRE SPRINKLER CONNECTIONS

A. Flexible Connection: Stainless steel hose, 175 psig max working pressure, fully welded non-mechanical fittings, stainless steel braid, maximum of 6' hose length, leak-tested with a minimum 7/8" internal corrugated hose diameter made of 304 stainless steel, end fittings made of carbon or stainless steel. Outlet of end fittings shall be 1/2" or 3/4" to match sprinkler connection. UL.

B. Ceiling Bracket: G90 galvanized steel, direct attachment type, integrated snap-on clip ends, tamper resistance screws, removable attachment hub with set screw for attachment and adjustment of stainless steel hose.

1. Manufacturers:
   a. Flexhead Industries
   b. Victaulic VicFlex,
   c. Sprinkflex
   d. or approved equal.

2.03 VALVES

A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.

B. Provide all connections to match pipe joints. Valves shall be same size as pipe.

2.04 EQUIPMENT

A. Equipment shall be as scheduled on the drawings.

2.05 RISER LABELING AND IDENTIFICATION

A. Hydraulic nameplates shall be affixed to each riser and shall include the following minimum information:

1. Installation contractor
2. Date installed
3. Riser location
4. Number of sprinklers
5. Basis of design (density GPM/ft2 and area of coverage ft2
6. Water flow rate (GPM) and residual pressure (psi) at the base of riser
7. Hose stream allowance (GPM).
8. Occupancy classification
9. Commodity classification (If applicable)
10. Maximum storage height (if applicable)

2.06 PIPE LABELING AND IDENTIFICATION

A. All pipe shall be marked along its length by the manufacturer in such a way as to properly identify the type of pipe. The manufacturer pipe marking shall be visible on every piece of pipe over 2 ft (600 mm) long. Manufacturer pipe identification shall include the manufacturer's name, model designation, and/or schedule.

PART 3 - EXECUTION

3.01 INSTALLATION - PIPING

A. General Installation Requirements:

1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
3. Die cut screw joints with full cut standard taper pipe threads.
4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer's installation instructions.

B. Steel Piping:

1. In steel piping, main sized saddle branch connections or direct connection of branches to main is permitted if main is one pipe size larger than the branch for up to 6" mains and if main is two pipe sizes larger than branch for 8" and larger mains. Do not project branch pipes into main pipes.

C. Wall/Floor Penetration:

1. Provide sleeves when penetrating floors and walls.
2. Seal pipes passing through exterior walls with a wall seal per Section 21 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe. Sleeves through floors shall extend minimum 1.5" above finished floor.
3. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

D. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

E. Hangers and Supports:

1. Provide hangers and supports as required by NFPA 13 and UL, with the following exceptions:
   a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
   b. Do not install fasteners to carry the load in tension, unless absolutely necessary.

F. Exposed Piping:

1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.
2. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories.

3.02 INSTALLATION - VALVES

A. Install gate valves with stems upright or horizontal, not inverted.

B. Shutoff Valve:

1. Provide drain valves at main shutoff valves, low points of piping and apparatus.
2. Provide monitor switches on all shutoff valves.

3.03 INSTALLATION - EQUIPMENT

A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.

B. Test Valves:

1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.

C. Sprinklers:

1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

3.04 SYSTEMS CLEANING AND TESTING

A. General Requirement:

1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.

B. Interior Piping:

1. Verify adequate water flow at the inspector's test connection.
2. Flush all interior piping to remove scale and other foreign material before placing system into service.
3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig more than the normal system working pressure for systems subjected to pressures more than 150 psig. Maintain test pressure for 2 hours without loss of pressure.

C. Fire Alarm System:

1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
2. Adjust all monitor switches for proper operation.

END OF SECTION

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SECTION 22 0500
BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the bid documents and/or Construction Manager's scope statements for complete scope of work description.

D. Scope of Work:

1. Plumbing Work shall include, but is not necessarily limited to:
    a. Furnish and install all items listed in the Plumbing Material List.
    b. Extend existing domestic water piping system including cold, hot, and hot water circulating piping within the building. Insulate all piping as specified.
    c. Extend existing gas piping system including all meter requirements.
    d. Furnish and install water softener.
    e. Furnish and install water heaters.
    f. Furnish and install condensate drain piping from plumbing related equipment such as ice machines.
    g. Furnish and install complete sanitary sewer and vent system.
    h. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work. Refer to 07 8400.
    i. Complete all applicable tests, certifications, forms, and matrices.
2. Heating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
3. Air Conditioning and Ventilating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
4. Temperature Control Work: Refer to Section 23 0500 "Basic HVAC Requirements".
5. Fire Protection Work: Refer to Section 21 0500 "Basic Fire Suppression Requirements".
6. Testing, Adjusting, and Balancing Work: Refer to Section 23 0500 "Basic HVAC Requirements".

1.03 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. The Owner reserves the right to determine when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 ALTERNATES

A. Bakery equipment: Rough-in is part of Base Bid.

B. Laundry equipment: Rough-in is part of Base Bid where noted on drawings. Refer to drawings for additional information on scope.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
   a. Plumbing Contractor.
   b. Heating Contractor.
   c. Air Conditioning and Ventilating Contractor.
   d. Temperature Control Contractor.
   e. Fire Protection Contractor.
   f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
   a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
    a. Light fixtures.
    b. Gravity flow piping.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:
1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
    a. Burners.
    b. Condensing Units.
    c. Gas Trains.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.

3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
   a. Scale of drawings:
      1) General plans: 1/4 Inch = 1 '-0" (minimum).
      2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
      3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
      4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).
      5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
   a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
   b. Potential layout changes shall be made to avoid additional access panels.

c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.

2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa's Codes, Laws, Ordinances and other regulations having jurisdiction.

2. Conform to all State Codes.

3. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.

4. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.

5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.

6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.

7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as sewer and water and gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
    a. Any item listed as furnished shall also be installed, unless otherwise noted.
    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification Section	Submittal Item
22 05 00	Owner Training Agenda
22 05 15	Variable Frequency Drives
22 05 16	Expansion Compensation
22 05 29	Hangers and Supports
22 05 48	Vibration Isolation Equipment
22 05 53	Plumbing Identification
22 07 16	Plumbing Equipment Insulation
22 07 19	Plumbing Pipe Insulation
22 09 00	Instrumentation
22 10 00	Plumbing Piping Systems and Valves
22 10 23	Natural Gas and Propane Piping Systems
22 10 30	Plumbing Specialties
22 11 23	Domestic Water Pumps
22 12 00	Plumbing Tanks
22 30 00	Plumbing Equipment
22 40 00	Plumbing Fixtures

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number

f. Notations of deviations from the contract documents

g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

a. Date

b. Project title and number

c. Architect/Engineer

d. Contractor and subcontractors' names and addresses

e. Supplier and manufacturer's names and addresses

f. Division of work (e.g., plumbing, heating, ventilating, etc.)

g. Description of item submitted (using project nomenclature) and relevant specification number

h. Notations of deviations from the contract documents

i. Other pertinent data

j. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
   a. Submittal file name: 22 XX XX.description.YYYYMMDD
   b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

C. Coordinate the installation of heavy and large equipment with all contractors and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.13 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.14 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first manufacturer is the basis for job design and establishes the quality.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (https://call811.com/) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.

5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6"sand bedding. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope around utilities to 6" above utilities: Place and compact sand to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
6. Dispose of excess excavated earth as directed.
7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.

2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.03 ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
   a. Pipe insulation is installed and fully sealed.
   b. Pipe wall penetrations are sealed.
   c. Pipe identification and valve tags are installed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.04 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div22.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, one paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.
16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.
5. Explanation of Owner’s Responsibilities to operate, maintain, and flush domestic water system (i.e., ASHRAE Standard 188).

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

F. Minimum hours of instruction for each item shall be:

1. Domestic Hot Water System - 2 hours
2. All Domestic Water Systems operation, maintenance and flushing of all fixtures and dead legs - 2 hours
3. Domestic Water Pressure Booster System - 4 hours.
4. Water Softener, Filtration and/or Purification System - 10 hours

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 SYSTEM STARTING AND ADJUSTING

A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.

D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.08 RECORD DOCUMENTS

A. The following paragraphs supplement Division 1 requirements.

B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices

located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

D. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.09 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.

E. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

F. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.
3. Color of paint shall be as follows:
    a. All piping in mechanical room:
        1) Natural Gas: Yellow pipe/black letters

3.10 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.11 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Refer to Division 00 and Division 01 specifications for additional requirements which may include special requirements for work within the correctional facility.

E. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

1. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All pumps operating and balanced.
3. All plumbing fixtures installed and caulked.
4. Pipe insulation complete, pipes labeled and valves tagged.
5. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 22 0505
PLUMBING DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Plumbing Demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.02 PREPARATION

A. Disconnect plumbing systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

C. Existing Plumbing System: Maintain service to all plumbing fixtures until new piping is installed. Obtain permission from Owner at least 48 hours before shutting down system for any reason. Make changeover to new piping with minimum outage. Do not disconnect any roof drainage piping until new piping is in place and operational.

3.03 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing plumbing work under provisions of Division 2 and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned piping to source of supply and/or main lines.

D. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

H. Remove unused sections of domestic water piping back to mains and cap. Capped pipe shall be less than 2 feet from main to prevent "dead legs".

I. Temporarily cap all openings to the sanitary and vent system to prevent odor from entering the work area and building.

3.04 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 22 0529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. PLUMBING ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.06 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 22 0513
MOTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single Phase and Three Phase Electric Motors.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.03 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories.

PART 2 - PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. Design motors for continuous operation in 40ºC environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.

D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.

F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.

G. Each contractor shall set all motors furnished by him.

H. All motors shall have a minimum service factor of 1.15.

I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.

J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.

K. Motor Driven Equipment:

1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

2.02 ELECTRICALLY COMMUTATED MOTORS (ECM)

A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.

B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.

C. All EC motors shall be a minimum of 85% efficient at all speeds.

D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.

E. Provide motor with onboard motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.

F. Operational mode shall be as scheduled and shall be one of the following:

1. Constant Flow
2. Constant Temperature
3. Constant Pressure

2.03 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

A. All motors, unless exempted by EPAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
HP	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5

B. Motor nameplate shall be noted with the above ratings.

2.04 MOTORS ON VARIABLE FREQUENCY DRIVES

A. All motors driven by VFDs shall be premium efficiency type.

B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.

D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.

1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.
2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

END OF SECTION

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SECTION 22 0516
PLUMBING EXPANSION COMPENSATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Expansion Joints and Compensators.

B. Pipe Loops, Offsets, and Swing Joints.

1.02 REFERENCES

A. Conform to Standards of Expansion Joint Manufacturer's Association.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500.

B. Expansion joint shop drawings shall include maximum motion.

1.04 DESIGN CRITERIA

A. Unless noted otherwise, base expansion calculations on 50°F installation temperature to 140°F for domestic hot water, plus 30% safety factor.

PART 2 - PRODUCTS

2.01 EXPANSION JOINTS

A. Type EJ-1:

1. Multiple plies of 300 series stainless steel bellows.
2. Rated for 150 psi working pressure at 250°F and 100psi at 400°F.
3. Cycle life shall be at least 1,000 full range (compression and extension) cycles at rated stroke and 6,000 cycles at 1/2 rated stroke.
4. Axial motion shall be as scheduled on the drawings, but not less than 2" (compression plus extension).
5. Provide removable metal insulation shroud around the bellows.
6. Joints 2" or smaller in copper piping systems shall have all copper, brass or bronze construction with stainless steel bellows and union ends or sweat ends with unions added.
    a. Manufacturers:
        1) American BOA Type KH
        2) Hyspan Type 8509
        3) Flexonics Model HB
        4) Metraflex Model HPMF
        5) Keflex Series 7QT
7. Joints 2" or smaller in ferrous piping systems shall have steel bodies with union ends or male threaded ends with unions added.
    a. Manufacturers:
        1) American BOA Type B
        2) Hyspan Type 8503
        3) Flexonics Model H
        4) Metraflex Model HP Keflex Series 7Q-MPT
8. Joints 2-1/2" or larger shall have 150 lb. forged steel flanges.
    a. Manufacturers:
        1) American BOA Model 3150FS or 3150FL
        2) Hyspan Model 1501

3) RM Model X-Flex-150 Multiply
4) Keflex Series 311-1215
5) Metraflex Model MNLC

B. Alignment Guides:
1. Bolted semi-steel spider.
2. Bolted guiding cylinder with supporting legs welded to pipe support.
3. Sized to allow insulation to pass through the outer cylinder.
a. Manufacturers:
1) American BOA
2) Hyspan, Flexonics
3) Keflex
4) Metraflex

PART 3 - EXECUTION

3.01 INSTALLATION

A. Accomplish structural work and provide equipment required to control expansion and contraction of piping; including loops, offsets, swing joints, and expansion joints where required.

B. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so all movement occurs along axis of pipe only.

C. Each expansion joint shall have either one anchor or two alignment guides on each side of it. Guides shall be located within 4 and 14 pipe diameters of the expansion joint or as recommended by the joint manufacturer.

D. Preset all expansion joints to allow for expected expansion from installation temperature to operating temperature.

END OF SECTION

SECTION 22 0529
PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.02 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 22 0500. Include plastic pipe manufacturers' support spacing requirements.

1.03 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to Division 3 Contractor for placement into formwork.

PART 2 - PRODUCTS

2.01 HANGER RODS

A. Hanger rods for single rod hangers shall conform to the following:

	Hanger Rod Diameter	
Pipe Size	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"
6"	3/4"	5/8"

Column #1: Steel and cast iron.

Column #2: Copper and plastic pipe.

B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.02 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, -69, -89, and -127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
3. Copper piping located in an exposed area, including indirect waste piping in kitchens and janitor's closets, shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

a. Products:
   1) Erico/M-Co Model #456
   2) B-Line Fig. 3198HCT
   3) Anvil Fig. CT138R
   4) Nibco/Tolco Fig. 301CT

B. Vertical Supports:
1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.
   a. Products:
      1) Cooper/B-Line Fig B3373 Series
      2) Erico 510 Series
      3) Nibco/Tolco Fig. 82
2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.
   a. Products:
      1) Mason RBA, RCA or RDA
      2) Mason BR
3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.
   a. Products:
      1) Pipeshields E100
4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.
5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:
1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.

5. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.
    a. Products:
        1) Anvil Fig. 160, 161, 162, 163, 164, 165
        2) Cooper/B-Line Fig. 3160, 3161, 3162, 3163, 3164, 3165.
        3) Erico Model 630, 631, 632, 633, 634, 635.
        4) Nibco/Tolco Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4
6. Unless otherwise indicated, hangers shall be as follows:
    a. Clevis Type:
        1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller
        2) Products: Bare Steel Plastic or Insulated Pipe:
            a) Anvil Fig. 260
            b) Cooper/B-Line Fig. 3100
            c) Erico Model 400
            d) Nibco/Tolco Fig. 1
        3) Products: Bare Copper Pipe:
            a) Cooper/B-Line Fig. B3100C
            b) Nibco/Tolco Fig. 81PVC
    b. Continuous Channel with Clevis Type: Service: Flexible Hose, Soft Copper Tubing:
        1) Products:
            a) Cooper/B-Line Fig. B3106, with Fig. B3106V
            b) Erico Model 104, with Model 104V
            c) Nibco/Tolco Fig. 1V
    c. Adjustable Swivel Ring Type:
        1) Service: Bare Metal Pipe - 4 inches and Smaller
        2) Bare Steel Pipe:
            a) Anvil Fig. 69
            b) Cooper/B-Line Fig. B3170NF
            c) Erico Model FCN
            d) Nibco/Tolco Fig. 200
        3) Bare Copper Pipe:
            a) Cooper/B-Line Fig. B3170CTC
            b) Erico 102A0 Series
            c) Nibco/Tolco Fig. 203
7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
    a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
   a. Clamp Type:
      1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller
      2) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
      3) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
      4) Bare Steel, Plastic or Insulated Pipe:
         a) Unistrut Fig. P1100 or P2500
         b) Cooper/B-Line Fig. B2000 or B2400
         c) Nibco/Tolco Fig. A-14 or 2STR
      5) Bare Copper Pipe:
         a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:
   1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
      a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):
         1) Products:
            a) Anvil Fig. 92
            b) Cooper/B-Line Fig. B3033/B3034
            c) Erico Model 300
            d) Nibco/Tolco 68
      b. Steel Structure Clamps: Scissor Type Beam Clamps (for use with bar-joists and wide flange):
         1) Products:
            a) Anvil Fig. 228, 292
            b) Cooper/B-Line Fig. B3054
            c) Erico Model 360
            d) Nibco/Tolco Fig. 329
      c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
         1) Products:
            a) MCL. M1, M2 or M3
      d. Concrete: Concrete Inserts, Single Rod Galvanized:
         1) Products:
            a) Anvil Fig. 282
            b) Cooper/B-Line Fig. B3014
            c) Erico Model 355
            d) Nibco/Tolco Fig. 310

e. Concrete: Concrete Inserts, Continuous Strip Galvanized:
   1) Products:
      a) Unistrut Corp P3200 Series
      b) Cooper/B-Line Fig. B22-J
      c) Erico CONCT

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

g. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

h. Steel Structure Welding:
   1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.03 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:
   1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
   2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):
   1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
   2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
   3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
   4. Equipment requiring bases is as follows:
      a. Expansion Tank
      b. Booster Pump
      c. Tank
      d. Water Heater
      e. Water Softener

C. Supports:
   1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
   2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.04 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the Division 3 Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.05 ROOF PENETRATIONS

A. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: Black shall match roofing membrane.

B. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

2.06 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.

F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.07 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.08 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.09 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.10 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.01 PLUMBING SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
   1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
   2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
      a. The hanger is attached within 6" from a web/chord joint.
      b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
   3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
   4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
   1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
      a. Maximum Spacing:
         1) 1-1/4" & under: 7'-0"
         2) 1-1/2": 9'-0"
         3) 2": 10'-0"
         4) 2-1/2": 11'-0"
         5) 3": 12'-0"
         6) 4" & larger: 12'-0"
   2. Steel (Std. Weight or Heavier - Vapor Service):
      a. Maximum Spacing:
         1) 1-1/4" and under: 9'-0"
         2) 1-1/2": 12'-0"
         3) 2" & larger: 12'-0"

3. Hard Drawn Copper & Brass (Liquid Service):
    a. Maximum Spacing:
        1) 3/4" and under: 5'-0"
        2) 1": 6'-0"
        3) 1-1/4": 7'-0"
        4) 1-1/2" 8'-0"
        5) 2": 8'-0"
        6) 2-1/2": 9'-0"
        7) 3": 10'-0"
        8) 4": 12'-0"
        9) 6": 12'-0"
4. Hard Drawn Copper & Brass (Vapor Service):
    a. Maximum Spacing:
        1) 3/4" & under: 7'-0"
        2) 1": 8'-0"
        3) 1-1/4": 9'-0"
        4) 1-1/2": 10'-0"
        5) 2": 11'-0"
        6) 2-1/2" & larger: 12'-0"
5. Plastic Pipe:
    a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

I. Installation of hangers shall conform to MSS SP-58, -69, -89, and the applicable Plumbing Code.

END OF SECTION

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SECTION 22 0548
PLUMBING VIBRATION ISOLATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Vibration Isolation.

B. Flexible Connectors.

1.02 SUBMITTALS

A. Submit shop drawings per Section 22 0500 and the Vibration Isolation Submittal Form at the end of this section.

B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.

C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.

D. Isolator submittals shall include:

1. Equipment served
2. Type of Isolator
3. Load in Pounds per Isolator
4. Recommended Maximum Load for Isolator
5. Spring Constants of Isolators (for Spring Isolators)
6. Load vs. Deflection Curves (for Neoprene Isolators)
7. Specified Deflection
8. Deflection to Solid (at least 150% of calculated deflection)
9. Loaded (Operating) Deflection
10. Free Height
11. Loaded Height
12. Kx/Ky (horizontal to vertical stiffness ratio - for spring isolators)
13. Materials and Coatings
14. Spring Diameters

E. Make separate calculations for each isolator on equipment where the load is not equally distributed.

F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

PART 2 - PRODUCTS

2.01 BASIC CONSTRUCTION AND REQUIREMENTS

A. Vibration isolation for this project is subject to seismic restraint requirements of Section 22 0550.

B. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

C. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

D. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

E. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

F. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

G. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.

H. Provide motor slide rails for belt-driven equipment per Section 22 0513.

I. All isolators, except M1, shall have provision for leveling.

J. All components in contact with potable water shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act and NSF/ANSI-61 Low Lead Requirements for Drinking Water.

2.02 MOUNTINGS

A. Type M1:

1. 0.75" thick waffled neoprene pad with minimum static deflection of 0.07" at calculated load and 0.11" at maximum load. For loads less than 15 pounds, the deflection at calculated load requirement is waived, but the isolator must have a maximum stiffness of the ratio of 45#/0.35" .
2. Units need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators.
    a. Manufacturers:
        1) Mason "Super W"
        2) Kinetics "NGS"
        3) Amber/Booth "SPNR"
        4) Vibration Eliminator Co. "400N".

B. Type M2:

1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.
2. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.
3. All units shall have bolt holes and be bolted down.
4. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.
    a. Manufacturers:
        1) Mason Industries "ND" or "DNR"
        2) Amber/Booth "RVD"
        3) Kinetics "RD"
        4) Vibration Mountings and Controls "RD"
        5) Vibration Eliminator Co. "T22" or "T44".

C. Type M3:

1. Free standing, laterally stable spring isolators without housings and complete with 1/4" neoprene friction pads.
2. Units shall have bolt holes but need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators. Bolt holes shall not be within the springs.

3. All mountings shall have leveling bolts.
    a. Manufacturers:
        1) Mason "SLFH"
        2) Kinetics "FDS"
        3) Amber/Booth "SW-3, 4", 5" or 6"
        4) Vibration Eliminator Co. "OST".

D. Type M4:
1. Use restrained spring mountings for equipment with operating weight different from the installed weight.
2. Spring isolators shall be free-standing with 1/4" neoprene acoustical friction pads.
3. All units shall have bolt holes and be bolted down. Prevent short circuiting with neoprene bushings and washers between bolts and isolators.
4. All mountings shall have leveling bolts.
5. Housings with vertical resilient limit stops shall prevent spring extension when weight is removed. Housings shall serve as blocking during erection and the installed and operating heights shall be the same.
6. Maintain a minimum clearance of 1/2" around restraining bolts and between the housings and the springs so as not to interfere with the spring action.
7. Limit stops shall be out of contact during normal operation.
8. Select isolators for equipment subjected to wind loads in conformance with ASCE 7-02.
    a. Manufacturers:
        1) Mason "SLRS"
        2) Kinetics "FLS"
        3) Aeroflex "AWRS"
        4) Vibration Eliminator Co. "KW".

2.03 HANGERS

A. Type H1:
1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.
    a. Manufacturers:
        1) Mason "HD"
        2) Kinetics "RH"
        3) Aeroflex "RHD"
        4) Vibration Eliminator Co. "IC/3C/3CTD"
        5) Vibro Acoustics "RH"

B. Type H2:
1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.

4. Provide end connections for hanging ductwork or piping.
    a. Manufacturers:
        1) Mason "30"
        2) Kinetics "SRH"
        3) Amber/Booth "BSRA"
        4) Aeroflex "RSH"
        5) Vibration Eliminator Co. "SNC".
        6) Vibro Acoustics "SH/SHC"

C. Type H3:
1. Vibration hangers shall have a steel spring in a neoprene cup with a grommet to prevent short circuiting of the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Hangers shall be capable of holding the load at a fixed elevation during installation. They shall have a secondary adjustment to transfer the load to the spring and maintain the same position.
6. Deflection shall be indicated by a pointer and scale.
    a. Manufacturer:
        1) Mason "30N"
        2) Kinetics "SFH"
        3) Amber/Booth "BSW"
        4) Vibration Eliminator Co. "SNRC"
        5) Vibro Acoustics "SHR"

2.04 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

A. Type FC3:
1. Rated for minimum working pressures of 150 psi at 70°F and 100 psi at 800°F.
2. Sizes 2" and under shall be braided bronze hose with copper sweat ends or stainless steel braided hose with stainless steel threaded nipples,
3. Sizes 2-1/2" and over shall be stainless steel braided hose with 150 lb. stainless steel flanges.
4. Suitable for 1/2" permanent misalignment.
5. All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act and NSF/ANSI-61 Low Lead Requirements for Drinking Water.
    a. Manufacturers:
        1) Mason or Mercer "CPSB-NSF", "NSS-NSF" or "FLSS-NSF"
        2) Metraflex "BBSC", SSTT or "MMCC"
        3) Twin City Hose "ULTCHB", "UL-TCHSSMMT" or "ULTCHSSFLG"
        4) Flexible Metal Hose Company "BSW", "SSMN" or "SSMP"

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as pipes supported on a strut rack.

3.02 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. For base mounted pumps without resilient mountings, the first five hangers shall be Type H1.

C. Where piping is floor-supported, use M2 instead of H1 and M3 instead of H2.

D. Install flexible connectors in all piping connected to vibration producing equipment. This includes all base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.

E. Use Type FC3 for all potable water services. FC3 shall be installed parallel with equipment shafts.

F. Provide sufficient piping flexibility for vibrating equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.

G. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.

H. Support piping to prevent extension of flexible connectors.

3.03 VIBRATION ISOLATION SCHEDULE

A. Inline Pumps:

1. Base Type: NA
2. Isolator Type: M3 or H2 or H3
3. Static Deflection: 0.75"
4. Flexible Connections: NA

B. Base-Mounted Domestic Water Booster Pumps:

1. Base Type: Reuse existing
2. Isolator Type: Reuse existing
3. Static Deflection: 0.75"
4. Flexible Connections: FC-3

C. Air Compressor:

1. Base Type: NA
2. Isolator Type: M1
3. Static Deflection: NA
4. Flexible Connections: NA

END OF SECTION

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VIBRATION ISOLATION SUBMITTAL FORM

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12
		PROPOSED ISOLATOR							CALCULATIONS		
ITEM SERVED	MIN DEFL (")	TAG	MODEL	MAX LOAD (#)	DEFL @ MAX LOAD (")	DEFL TO SOLID (")	FREE HT (")	Kx/Ky	LOAD (#)	DEFL (")	DEFL RATIO

COLUMN NOTES: Note numbers correspond to the column numbers above.

1. Item served should match designation on the design drawings.
2. List the deflection scheduled or specified in the design documents.
3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
4. List the manufacturer's complete model designation for the isolator.
5. List the manufacturer's maximum rated load for the isolator.
6. List the isolator deflection at the maximum rated load in column 5.
7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

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SECTION 22 0553
PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Identification of products installed under Division 22.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

1. 3M
2. Bunting
3. Calpico
4. Craftmark
5. Emedco
6. Kolbi Industries
7. Seton
8. W.H. Brady
9. Marking Services

2.02 MATERIALS

A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
Plastic tags may be used for outside diameters under 3/4"		

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

D. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

E. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.

F. Tracer Wire:

1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.
2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
6. Number all tags and show the service of the pipe.
7. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Apply markers and arrows in the following locations where clearly visible:
   a. At each valve.
   b. On both sides of walls that pipes penetrate.
   c. At least every 20 feet along all pipes.
   d. On each riser and each leg of each "T" joint.
   e. At least once in every room and each story traversed.
3. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Provide engraved plastic tags at all hydronic or steam system makeup water meters.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Tracer Wire:

1. Tracer wire shall be installed on top of all non-metallic buried utilities.
2. Tracer wire shall be taped directly to plastic water or drain pipe.
3. Tracer wire shall not be fastened directly or indirectly to gas piping.
4. Tracer wire when attached shall be secured to the pipe a minimum of every 10 feet and at all changes of direction.
5. Tape shall be Polyken "930-35", Protecto-Wrap "310", or approved equal.
6. Tracer wire shall be continuous between boxes and shall be tested for continuity.
7. Splices in tracer wire shall be made with a water proof splice kit to prevent corrosion. Wire nuts shall not be used.
8. The tracer wire shall daylight to grade through a 2" PVC conduit, at the point of the utility entrance to building. PVC conduit shall be capped and labeled as future contact point to locate the utility.

3.02 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. CONDENSATE DRAIN: White lettering; green background
2. DOMESTIC COLD WATER: White lettering; green background
3. DOMESTIC HOT WATER - 140°F: White lettering; green background
4. DOMESTIC HOT WATER CIRCULATING - 140°F: White lettering; green background
5. SANITARY SEWER: Black lettering; yellow background
6. VENT: Black lettering; yellow background
7. NATURAL GAS: Black lettering; yellow background
8. TEMPERED WATER: White lettering; green background
9. All Underground Pipes: Varies
10. Tracer Wire - Natural Gas Pipe Lines: Black lettering; yellow background
11. Tracer Wire - All other buried types: White lettering; green background

B. Non-Potable Piping: All piping conveying non-potable water shall be permanently identified by continuously painted or continuous adhesive backed marker along entire length of pipe and branches so the piping is readily distinguishable from piping carrying potable water. Pipe markers shall be located as described above.

1. NON-POTABLE WATER: White lettering; purple background
2. RO WATER: White lettering; purple background

END OF SECTION

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SECTION 22 0716
PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Equipment Insulation.

B. Equipment Insulation Finishes.

1.02 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500. Include product description, list of materials and thickness for equipment scheduled.

PART 2 - PRODUCTS

2.01 INSULATION

A. Type B: Glass Fiber Board; ANSI/ASTM C612; 0.28 maximum 'K' value at 200°F; 6.0 lb./cu ft; suitable to 850°F, 25/50 flame spread/smoke developed.

B. Type C: EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

2.02 INSULATION FINISHES

A. Type 1: Glass Fabric; ASTM D1668, woven glass fabric with two coats of mastic approved for insulation type. Use vapor barrier mastic on system requiring a vapor barrier.

B. Type 2: All Service Jacket; ASTM C921; Factory or Field Applied; all-purpose polymer or polypropylene service jacket; Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Seal all joints with manufacturer approved tape and adhesive to maintain vapor barrier. Indoor use only, if used outdoors add type 4 finish.

C. Type 3: Flexible Elastomeric Thermal Insulation; After adhesive has fully cured, apply two coats of latex enamel paint approved by insulation manufacturer for outdoor use.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all materials per manufacturer's instructions, codes and industry standards.

B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

C. Do not insulate factory insulated equipment.

D. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.

F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.

G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.

H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.

I. Insulate all equipment surfaces that are not factory insulated and are intended to operate below 60°F and/or above 100°F. Verify insulation type and thickness with equipment manufacturer and Architect/Engineer.

J. Insulate all supports on equipment operating below ambient temperature.

3.02 INSULATION

A. Type B:

1. Apply with edges tightly butted and joints staggered.
2. Secure with welded pins and washers, 4" from each edge and 16" on center, or 1/2" x 0.015" galvanized steel bands, 12" on center.

B. Type C:

1. Apply with edges tightly butted and joints staggered. Install multiple layers if required thickness is greater than 1" thick.
2. Secure with manufacturer approved adhesive. Seal all joints with manufacturer approved adhesive.

3.03 SCHEDULE

A. Domestic Hot Water Storage Tank (up to 250°F): 2" thick Type B; Finish 1 or 2.

B. RO Pneumatic Pressure/Storage Tank:

1. 1" thick Type B; Finish 1 or 2
2. 1" thick Type C, Finish 3.

C. Water Softener Tank:

1. 1" thick Type B, Finish 1 or 2
2. 1" thick Type C, Finish 3.

END OF SECTION

SECTION 22 0719
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping Insulation.

B. Insulation Jackets.

1.02 QUALITY ASSURANCE

A. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.01 INSULATION

A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.29 maximum 'K' value at 75°F; density 7.3lb/ft; minimum compressive strength 90 psi parallel to rise; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations, use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose polymer or polypropylene service jacket for above grade installations.

D. Type E: Preformed rigid cellular polyisocyanurate insulation; ANSI/ASTM C591; maximum 'K' value of 0.19 at 75°F; density 4.0lb/ft; minimum compressive strength 95 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -297°F to +300°F.

2.02 VAPOR BARRIER JACKETS

A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

2.03 JACKET COVERINGS

A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

3.02 INSTALLATION

A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.

B. Insulated Piping Operating Below 60°F:

1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

3.03 SUPPORT PROTECTION

A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.

B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
    a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    b. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" to 10". For pipe sizes larger than 10", provide rolled steel plate in addition to the shield Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall be listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
    c. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.

d. Phenolic (for pipes operating below 250°F with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.

e. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.

1) Products:

a) Buckaroo CoolDry

b) Cooper/B-Line Fig. B3380 through B3384

c) Pipe Shields A1000, A2000

f. Insulation Couplings:

1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.

2) Horizontal Strut Mounted Insulated Pipe Manufacturers:

a) Klo-Shure or equal

3) Vertical:

a) Manufacturers: Klo-Shure Titan or equal

g. Rectangular blocks, plugs, or wood material are not acceptable.

h. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5” to 6"	18" long x 16 gauge

F. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

3.04 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.

2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.

3. Apply insulation with laps on top of pipe.

4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
    a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
    b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
    a. Install preformed sections of same material as straight segments of pipe insulation when available.
    b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
    c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type C Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
2. Insulate fittings with prefabricated fittings.

D. Type E Insulation:

1. Indoors, above grade or below grade, Polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
2. Insulate pipe fittings with prefabricated insulation fittings.

3.05 JACKET COVER INSTALLATION

A. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. All joints in areas noted shall meet USDA standards for Totally Sealed Systems, including overlaps of 1" on circumferential and 1.5" to 2" on longitudinal seams.

5. Use plastic insulation covering on all exposed pipes including, but not limited to:
   a. All exposed piping below 8'-0" above floor.
   b. All piping in mechanical rooms and/or tunnels that are subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
   c. All kitchen areas.

3.06 SCHEDULE

A. Refer to drawings for insulation schedule.

END OF SECTION

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SECTION 22 0900
INSTRUMENTATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pressure Gauge.

B. Pressure Gauge Accessories.

C. Thermometers.

D. Test Plugs.

1.02 SUBMITTALS

A. Submit shop drawings per Section 22 0500. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.

1. Manufacturers:
    a. Ashcroft
    b. Marsh
    c. Marshalltown
    d. Miljoco
    e. Trerice
    f. U.S. Gauge Figure 1901
    g. Weiss
    h. Weksler
    i. Wika.

B. Select gauge range for normal reading near center of gauge.

2.02 PRESSURE GAUGE ACCESSORIES

A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.

B. Shutoff Valve: 1/4" ball valve as specified for each piping system.

C. Pressure snubber, brass with 1/4" connections, porous metal type.

2.03 THERMOMETERS

A. Alcohol/Spirit Filled Type:

1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, and locking device to allow rotation of thermometer to any angle.
2. Select thermometer for appropriate temperature range.
3. Stem: Copper plated steel, aluminum, or brass for separable socket. Stem lengths as required for application with minimum insertion of 3-1/2".
4. Thermometers for water shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

5. Manufacturer:
    a. Marsh
    b. Miljoco
    c. Trerice
    d. Weiss
    e. Weksler
    f. Wika.

B. Select scales to cover expected range of temperatures.

2.04 TEST PLUGS

A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.

B. Provide extended units for all plugs installed in insulated piping.

C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" diameter pressure gauge with 0-100 psi range, one gauge adapter with 1/8" probes, two 1-1/2" dial thermometers with 0° to 220°F and -25°F to 125°F ranges and 5" stems.

D. Manufacturers:
    1. Sisco
    2. Flow Design
    3. Peterson Equipment
    4. MG Piping Products Co.
    5. Miljoco
    6. Trerice
    7. Watts Regulator.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:
    1. Install per manufacturer's instructions.
    2. Coil and conceal excess capillary on remote element instruments.
    3. Install gauges and thermometers in locations where they are easily read from normal operating level.
    4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Pressure Gauges:
    1. Connect pressure gauges to suction and discharge side of all pumps.
    2. Provide snubber for each pressure gauge.

C. Thermometers:
    1. Install piping system thermometers in sockets with short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
    2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.

END OF SECTION

SECTION 22 1000
PLUMBING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe and Pipe Fittings.

B. Valves.

C. Check Valves.

1.02 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

1.05 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 0500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.01 CAST IRON PIPE

A. Cast Iron; Standard Weight; Hub and Spigot Joints:

1. Pipe: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
2. Design Pressure: Gravity Maximum Design Temperature: 180°F
3. Joints: Compression gasket, ASTM C564.
4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 301. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
5. Adapters: Heavy duty no-hub transition for joining cast iron and PVC pipe. Adapters shall be tested and certified to ASTM C 1460 and be constructed with Type 304 stainless steel shield, thickness 0.015" shield, gasket material to meet ASTM C564, 1-1/2" to 4" will be 3" wide with four 304 stainless steel bands, and 6" to 10" will be 4" wide with six 304 stainless steel bands and 3/8" 305 stainless steel hex head screws torqued to 80 inch pounds.

2.02 COPPER PIPE

A. Copper Pipe; Type L; Solder Joints:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

B. Copper Pipe; Type L; Mechanical Press Connection:
   1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
   2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
   3. Joints: Mechanical press connection.
   4. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
   5. Manufacturers:
      a. Viega ProPress
      b. Elkhart Xpress
      c. Nibco Press System Fittings and Valves
      d. Mueller Streamline PRS

C. Copper Pipe; Type K; Solder Joints:
   1. Pipe: Type K annealed copper tube, ASTM B88.
   2. Design Pressure: 150 psi. Maximum Design Temperature: 200°F.
   3. Joints: Solder with 100% lead-free solder and flux ASTM B32 BCuP silver braze, AWS A5.8.
   4. Fittings: Wrought copper solder joint, ANSI B16.22.

D. Copper Pipe: Type M; Solder Joints:
   1. Pipe: Type M hard temper seamless copper drainage tube, ASTM B306.
   2. Design Pressure: Gravity Maximum Design Temperature: 180°F
   3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
   4. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

2.03 PLASTIC PIPE

A. Cross-Linked Polyethylene (PEX); Cold Expansion Joint:
   1. Tubing: Cross-linked polyethylene (PEX-a or PEX-b), SDR-9, ASTM F876, NSF Certified
   2. Design Pressure/Temperature: 100 psig at 180°F.
   3. Joints: Bending the tubing greater than eight (8) times the outside diameter shall be permitted. Bends less than eight (8) times the outside diameter shall be barbed insertion fittings provided by the manufacturer.
   4. Fittings: Cold expansion joint compatible with engineered polymer or lead-free brass construction. System shall conform to ASTM F1960. Fittings for Reverse Osmosis water shall be engineered polymer.
   5. Limitations: Shall not be used in a return air plenum unless specifically listed to ASTM E84/UL723.

B. Virgin Rigid Chlorinated Polyvinyl Chloride (CPVC); Schedule 80; Solvent Weld Joints:
   1. Tubing: Virgin rigid chlorinated polyvinyl chloride (CPVC). Iron Pipe Size (IPS) Schedule 80 with a cell class of 23447-B, ASTM D1784, NSF Certified.
   2. Design Pressure/Temperature: 100 psig at 180°F for 2-1/2" pipe, 185 psig at 140°F for 3" pipe, 160 psig at 140°F for 4" pipe, 140 psig at 140°F for 6" pipe, 125 psig at 140°F for 8" pipe.
   3. Joints: Solvent cement, ASTM F493.
   4. Fittings: Same as tubing. Fittings and tubing shall be a system provided by the same manufacturer.
   5. Limitations: Shall not be used in a return air plenum unless specifically listed to ASTM E84/UL723.
   6. Special Requirements: Provide expansion loop(s) and/or Schedule 80 expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 0516 for expansion joint requirements.

C. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints:

1. Pipe: Schedule 40 rigid, PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
3. Fittings: PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
4. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
6. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 0516 for expansion joint requirements.

D. Chlorinated Polyvinyl Chloride (CPVC); Schedule 40 Drainage; Solvent Weld Joints:

1. Pipe: Chlorinated polyvinyl chloride (CPVC) Schedule 40 drainage pipe, ASTM F1412, NSF Listed.
2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer, ASTM F493.
3. Fittings: Chlorinated polyvinyl chloride (CPVC) DWV pattern with socket ends for Schedule 40 pipe.
4. Limitations: CPVC shall not be used in a return air plenum unless it is specifically listed to ASTM E84 and/or UL723. CAN ULC S102.2 listing is not acceptable.
5. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 0516 for expansion joint requirements.

2.04 STAINLESS STEEL PIPE

A. Stainless Steel; Schedule 5; Type 304; Mechanical Press Connection:

1. Pipe: Schedule 5 Type 304 stainless steel, ASTM A312 and ASTM A554 in copper tube size conforming to ASTM B88.
2. Joints: Mechanical press connections.
3. Fittings: Type 304 stainless steel, ASTM B88 and ANSI B16.22 with embedded O-ring. NSF-61 stainless steel grip ring for 2 1/2" to 4" diameter sizes.
4. Transitions to other materials: Provide dielectric connection as required in this section. Refer to article "CONNECTIONS BETWEEN DISSIMILAR METALS."
5. Special Requirements: Mechanical press fitting manufacturer shall provide contractor training prior to installation.
6. Manufacturers:
   a. Viega ProPress

B. Stainless Steel; Type 316; Hub and Spigot Joint:

1. Pipe: Stainless Steel Type 316L, ASME A112.3.1
2. Design Pressure: Gravity. Design Temperature: 200°F minimum.
3. Fittings: Stainless Steel Type 316L, ASME A112.3.1, push-on joints.
4. Joints: Push-on joint with integral rubber gaskets suitable for use with greasy waste typical for kitchen grease sanitary applications.
5. Adapters: Transition from stainless steel pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C564, 300 Series stainless steel shield, clamp and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

6. Manufacturers:
    a. Blucher
    b. Watts
    c. Josam
    d. Approved equivalent

2.05 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Butterfly Valves:
    a. BF-1:
        1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, Stockham LD712-B&3-E, Nibco LD2000N Series, Milwaukee CL series, Hammond 5200 series.
        2) 8" thru 12", 175# CWP, elastomers for 20°F to 225°F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1G, Stockham LD722-B&3-E, Nibco LD2000N Series, Milwaukee CL series, Hammond 5200 series.
3. Ball Valves:
    a. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
        1) Provide solid extended shaft for all insulated piping.
        2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.
    b. BA-7: 2" and under, 125 psi at 95°F, 35 psi at 140°F, socket weld, PVC, true union ball valve with PTFE ball seats, EPDM O-ring seals. George Fischer 346, Asahi Omni, Nibco Tru-bloc.

B. Throttling Valves

1. Globe Valves:
    a. GL-1: 2" and under, 150# saturated steam, 300# CWP, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, Nibco T-235Y.
    b. GL-2: 2-1/2" thru 10", 125# steam @ 353°F, 200# CWP @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #8906F, Milwaukee #F2981, Watts #F-501, Nibco F-718B.

2.06 STRAINERS

A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

B. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777.

C. ST-7: 2-1/2" thru 8", bronze body, flanged ends, flanged cover, 150# steam, 225# CWP. Mueller Steam Specialty Co. #851.

2.07 CHECK VALVES

A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

B. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.

C. CK-14: 2-1/2" thru 12", 200# CWP, double disc wafer type, bronze or iron body, bronze trim, metal-to-metal or Viton seat, 316 SS shaft, Inconel 600 spring. Mission Duo Chek #12HPP (with Inconel springs), Mueller Steam Specialty Co. #71-AHB-K-W, Stockham #WG-961-EPDM or #WG-970-BUNA, Nibco w-920-W.

2.08 LOCK OUT TRIM

A. Provide lock out trim for all quarter turn shutoff valves opening to atmosphere and installed in domestic water piping over 120°F and as indicated on the drawings.

2.09 VALVE OPERATORS

A. Provide handwheels for gate valves and gear operators for butterfly valves.

2.10 VALVE CONNECTIONS

A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

2.11 CONNECTIONS BETWEEN DISSIMILAR METALS

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron and steel connected to each other.
2. Brass, copper, and bronze connected to each other.
3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.
2. Manufacturers:
   a. Elster Group ClearFlow fittings
   b. Victaulic Series 647
   c. Grinnell Series 407
   d. Matco-Norca

F. Flanged Joints (any size):
   1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
   2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
   3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
   4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
   5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
   6. Manufacturers:
      a. EPCO
      b. Central Plastics
      c. Pipeline Seal and Insulator
      d. F. H. Maloney
      e. Calpico

PART 3 - EXECUTION

3.01 PREPARATION

A. Install all products per manufacturer's recommendations.
B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
C. Remove scale and dirt, on inside and outside, before assembly.
D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
E. Connect to equipment with flanges or unions.
F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
G. Roof Penetration (Vent) Flashing:
   1. Membrane, Metal or Shingled Roofs: Flash vents with premolded pipe flashing cones for single-ply membrane roofs, metal roofs, or shingled roofs.

3.02 SYSTEM, PIPING AND VALVE SCHEDULE

A. Cold Water, Hot Water, Tempered Water - Potable and Non-Potable (Above Ground):
   1. Copper Pipe; Type L; Solder Joints: All Sizes
   2. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
   3. Stainless Steel; Schedule 5; Type 304; Mechanical Press Connection: 4" and Under
   4. Cross-Linked Polyethylene (PEX); Cold Expansion Joints: 3" and Under
   5. Virgin Rigid Chlorinated Polyvinyl Chloride (CPVC); Schedule 80; Solvent Weld Joints: 2-1/2" to 8"
   6. Shutoff Valves: BF-1, BA-1
   7. Throttling Valves: GL-1, GL-2
   8. Check Valves: CK-1, CK-14
   9. Strainers: ST-1, ST-7
B. Cold Water, Hot Water - Potable (Underground):
   1. Copper Pipe; Type K; Solder Joints: All Sizes
   2. Cross-Linked Polyethylene (PEX); Cold Expansion Joint: 3" and Under

C. Sanitary Waste and Vent, Gravity (Above Ground):
   1. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes

D. Sanitary Indirect Drainage (Above Ground):
   1. Copper Pipe: Type M; Solder Joints: 1-1/4" to 4"

E. Sanitary Waste and Vent, Gravity (Underground - Inside Building):
   1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
   2. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes - not allowed for any waste water piping from trench drain in laundry room through lint interceptor or in 6" sanitary main until it connects to 6" sanitary main in Corridor 1210. Not allowed in sanitary piping from dishwasher drain #192 until it reaches 6" main in Passage 1208

F. Kitchen Grease Drainage and Vent (Above Ground):
   1. Stainless Steel; Type 316; Hub and Spigot Joint: 2" to 8"
   2. Chlorinated Polyvinyl Chloride (CPVC); Schedule 40 Drainage; Solvent Weld Joints

G. Kitchen Grease Drainage and Vent (Underground):
   1. Stainless Steel; Type 316; Hub and Spigot Joint: 2" to 8"
   2. Chlorinated Polyvinyl Chloride (CPVC); Schedule 40 Drainage; Solvent Weld Joints. (Not allowed on piping receiving discharge from steamers and rack ovens where noted on drawing

H. Reverse Osmosis:
   1. Cross-Linked Polyethylene (PEX); Cold Expansion Joints: 3" and Under. Fitting shall be plastic, not lead free brass construction.
   2. Shutoff Valves: BA-7

I. Condensate/Equipment Drainage:
   1. Copper Pipe: Type M; Solder Joints: 1-1/4" to 4"

3.03 TESTING PIPING

A. Sanitary Drainage, Sanitary Vent:
   1. Test all piping with water to prove tight.
   2. Test piping before insulation is applied.
   3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
   4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
   5. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
   6. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.
   7. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.

B. Hot Water - Potable and Non-Potable, Cold Water - Potable and Non-Potable:
   1. Test pipes underground or in chases and walls before piping is concealed.
   2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
   3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
   4. Hold test pressure for at least 2 hours.
   5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.

C. All Other Piping:

1. Test piping at 150% of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean all piping after testing is complete.

3.04 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

3.05 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.
7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
8. Seal pipes passing through exterior walls with a wall seal per Section 22 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
9. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
10. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

C. Installation Requirements in MRI (Magnetic Resonance Imaging - Healthcare):

1. All piping in MRI rooms shall be non-ferrous regardless of materials described on Part 2.

D. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
2. Provide clearance for installation of insulation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.
5. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
6. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

E. Underground Piping:

1. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements

F. Sanitary Piping:

1. Install all sanitary piping inside the building with a slope as shown on the drawings.
2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
3. Slope sanitary piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.
4. Sway Bracing: Where horizontal sanitary pipes 4 inches and larger change flow direction greater than 45°, rigid bracing or thrust restraints shall be installed to resist movement of the upstream pipe in the direction of pipe flow. The rigid bracing or thrust restraint shall be connected to structure. A change of flow direction from horizontal into a vertical pipe does not require the upstream pipe to be braced.
5. All sanitary piping shall have at least 42" of cover when leaving the building.
6. Starter fittings with internal baffles are not permitted.

3.06 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.

B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.

D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.

E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.

F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.

G. Provide flanges or unions at all final connections to equipment, traps and valves.

H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.

I. Use full and double lengths of pipe wherever possible.

J. Unless otherwise indicated, install all piping, including shutoff valves and strainers to coils, pumps, and other equipment at line size with reduction in size being made only at control valve or equipment.

K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.

L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements.

M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.

N. Do not use geotextile fabric with footing tile if silt content of soil exceeds 40% or if clay content exceeds 50%. The fabric shall be installed around 1" river rock or 2" limestone.

3.07 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal water lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.

B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.

C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.

D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.

E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.

F. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.

G. All vent and drain piping shall be of same materials and construction for the service involved.

3.08 PLUMBING VENTS

A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.

B. Extend the high side of the soil and waste stacks at least 12" above roof.

C. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by Roofing Contractor. Secure top of cone with stainless steel clamp and seal watertight.

D. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.

E. In no case shall the vent through the roof be less than 4" in diameter.

F. Vent pipes through the roof shall be located a minimum of 10 feet from any air intake opening on the roof.

3.09 BRANCH CONNECTIONS

A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.

D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:

1. Domestic water piping above ground.

E. Further limit use of mechanically formed fittings as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be Type K or L copper tubing.
   3. Permanent marking shall indicate insertion depth and orientation.
   4. Branch pipe shall conform to the inner curve of the piping main.
   5. Main must be 1" or larger.
   6. Branch must be 3/4" or larger.

F. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

G. Forged weld-on fittings are limited as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be 2-1/2" or larger.
   3. Branch line is at least two pipe sizes under main size.

3.10 JOINING OF PIPE

A. Solder Joints (Copper Pipe):
   1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
   2. Flux shall be non-acid type.
   3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

B. Brazed Joints (Copper Pipe):
   1. Make up joints with silver alloy brazing filler metal conforming to ASTM B260 "Brazing Filler Metal" BAg-1 or BAg-2. Cut copper tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to brazing. Apply non-corrosive flux of the type recommended by filler alloy manufacturer, evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly using oxygen-acetylene torch with tip size recommended by fitting manufacturer. Wipe and brush joint clean after alloy has set.
   2. Remove discs from solder end valves during brazing.

C. Mechanical Press Connection (Copper and Stainless Steel Pipe):
   1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
   2. Fully insert tubing into the fitting and mark tubing.
   3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
   4. Joint shall be pressed with a tool approved by the manufacturer.
   5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

D. Solvent Weld Joints (PVC):
   1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.

E. Solvent Weld Joints (CPVC):

1. Make joints with a one-step process. Use CPVC cement conforming to ASTM F493. A primer is not required.
2. If a primer is required by the Authority Having Jurisdiction, then a primer conforming to ASTM F656 shall be used.

F. Cold Expansion Joint (PEX):

1. Cold expansion joints shall be made in accordance with manufacturer's installation instructions.
2. All installers shall undergo training provided by the manufacturer or manufacturer's representative.

3.11 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfection of the domestic water piping shall be completed within three (3) weeks prior to building occupancy. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed within two (2) weeks prior to building occupancy.

B. Provide necessary connections at the start of individual sections of mains for adding chlorine.

C. Before starting work, verify system is complete, flushed and clean.

D. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

F. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.

G. Verify initial chlorination levels by testing at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main.

H. Maintain disinfectant in system for 24 hours, after which test at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.

I. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet/second until residual is equal to that of incoming water or 1.0 mg/L.

J. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

3.12 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work check invert elevations needed for sewer connections, confirm inverts and verify these can be properly connected with slope for drainage and cover to avoid freezing.

END OF SECTION

SECTION 22 1023
NATURAL GAS PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe and Pipe Fittings.

B. Valves.

C. Natural Gas Piping System.

1.02 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 22 05 00. Include data on pipe materials, fittings, valves, and accessories.

B. Test Reports: Provide results of piping system pressure test.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.

B. Deliver and store valves in shipping containers with labeling in place.

1.05 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.01 NATURAL GAS (0 to 125 PSI)

A. Design Pressure: 125 psi. Maximum Design Temperature: 350°F

B. Piping - 2" and Under:

1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.
2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)
3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.

C. Piping - 2" and Under:

1. Pipe: Corrugated stainless steel tubing, ASTM A240 Series 300 stainless steel, ANSI AGA-LC1.
2. Jacket: Polyethylene.
3. Fittings: Brass with mechanical ends to fit tubing. ASME B1.20.1 threaded ends for connections to threaded pipes and components.
4. Striker Plates: Minimum 16 gauge hardened steel, corrosion resistant, primed and zinc coated. Install to protect tubing from penetrations.
5. Limits: 5 psi or less. For use only at termination to fixed outlets or equipment, maximum length: 48". Provide malleable iron, flange mounted, straight or 90 fitting at wall termination with maximum 12" length of tubing on inlet of flange.

6. Manufacturers:
    a. TracPipe
    b. Gastite
    c. Parker (Parflex)
    d. Proflex (1 Yellow CSST)

D. Piping - 2-1/2" and Over:
1. Pipe: Standard weight steel, beveled ends, ASTM A53.
2. Joints: Butt welded or flanged.
3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.

E. Piping - All Sizes:
1. Pipe: Polyethylene pipe, ASTM D2513, SDR 11.5.
2. Joints: Fusion welded.
3. Fittings: Socket type, ASTM D2683 or ASTM D2513.
4. Limits: Use only below ground outside of buildings.
5. Transition Riser (Polyethylene to Steel Transition):
    a. Provide transition riser fitting by Central or equal when offsetting from below grade polyethylene to above grade Schedule 40 black steel piping.
    b. Joints: ASTM A53 Schedule 40 steel epoxy coated casing welded or threaded end; the polyethylene end shall be fusion welded.

F. For Underground Gas Piping - Refer to paragraph "Underground Piping Protection."

G. Shutoff Valves/Throttling Valves:
1. BA-13: 2" and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing.
    a. Manufacturers:
        1) Apollo #80-100
        2) Nibco #T580-70-UL or #T585-70-UL
        3) Watts #B-6000
2. PL-1: 2" and under, 125# steam @ 450°F, 175# CWP @ 180°F, cast iron body, screwed, full port.
    a. Manufacturers:
        1) Walworth #1700
        2) DeZurik #425, S-RS49
3. PL-2: 2-1/2" thru 4", 125# steam @ 450°F, 175# CWP @ 180°F, flanged, cast iron body, full port.
    a. Manufacturers:
        1) Walworth #1700F
        2) DeZurik #425, F-RS49

H. Check Valves:

1. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing.
    a. Manufacturers:
        1) Crane #37
        2) Hammond #IB904
        3) Stockham #B319-Y
        4) Walworth #3406
        5) Milwaukee #509
        6) Watts #B-5000
        7) Nibco Y-413B
2. CK-13: 2-1/2" thru 12", 200# CWP, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.
    a. Manufacturers:
        1) Mueller Steam Specialty Co. #71-AHB-6-H
        2) Stockham #WG-961 EPDM or #WG970 BUNA
        3) NIBCO W-920-W
        4) Crane

I. Strainers:

1. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi CWP @ 150°F.
    a. Manufacturers:
        1) Armstrong #A1FL
        2) Metraflex #TF
        3) Mueller Steam Specialty Co.#751
        4) Sarco #CI-125
        5) Watts #77F-D
2. ST-4: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 300# CWP @ 150°F.
    a. Manufacturers:
        1) Armstrong #A1SC
        2) Metraflex #SM
        3) Mueller Steam Specialty Co. #11
        4) Sarco #IT

2.02 STRAINERS

A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

1. Gases:
    a. 1/4" - 2": 1/32" perforations
    b. 2-1/2" - 10": 3/64" perforations

B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.

C. Use iron body strainers in ferrous piping.

2.03 DRAIN VALVES AND BLOWDOWN VALVES

A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

D. Connect to all equipment with flanges or unions.

E. After completion, fill, clean, and treat systems. Refer to Section 23 2500 for treatment.

3.02 TESTING PIPING

A. Low Pressure - Up to 1 psi:

1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.

B. High Pressure - Above 1 psi:

1. Test piping with compressed air at twice the operating gas pressure, but at least 20 psi. System must hold this pressure without adding air for two hours.

C. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

3.03 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.

2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.

3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.

4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

3.04 INSTALLATION

A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.

B. Install piping to conserve building space, and not interfere with other work.

C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Install thrust blocking and restraints on all buried piping at elbows and other changes in pipe direction.

G. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.

H. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.

I. Provide clearance for access to valves and fittings.

J. Provide access doors where valves are not exposed.

K. Prepare pipe, fittings, supports, and accessories for finish painting.

L. Install valves with stems upright or horizontal, not inverted.

M. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

N. Provide shutoff valves to isolate part of systems and vertical risers.

O. Provide shutoff valves to boilers and water heaters in readily accessible location, maximum 6 feet above finished floor, within 6 feet of boiler connection per ASME CSD-1.

P. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

Q. Reducers are generally not shown. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.

R. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.

S. Seal pipes passing through exterior walls with a wall seal per Section 22 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

T. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements.

U. Underground Piping Protection:

1. Direct buried, uninsulated steel pipe shall have a factory applied external protective coating consisting of two coats with an intermediate layer of 18 mil fibrous glass mat. Coating thickness shall total not less than 3/32". The outer coating shall be further protected by a wrapping of heavy Kraft paper. This external protection shall extend and be exposed for a minimum of 1 foot beyond the buried or concealed portion of the pipe.
2. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.
3. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
4. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
5. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
6. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

V. All vertical pipe drops to equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

W. Install underground plastic pipe with an electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape per section 22 05 53 to facilitate locating. One end of the tracer wire or tape shall be brought aboveground at a building wall or riser.

X. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

3.05 BONDING AND GROUNDING

A. Each above ground portion of a corrugated stainless steel tubing gas piping systems shall be bonded to the electrical service grounding electrode system. The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first downstream corrugated stainless steel tube fitting. The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent. Gas piping systems that contain one or more segments of corrugated stainless steel tubing shall be bonded in accordance with this section.

B. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.

C. Gas piping shall not be used as a grounding conductor or electrode.

D. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

3.06 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.

B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.

F. Use full and double lengths of pipe wherever possible.

G. Cut all pipe to exact measurement and install without springing or forcing.

H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

I. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Provide and operate sufficient pumping equipment to maintain excavations, trenches and pits free of water. Dispose of pumped water so operation areas and other facilities are not flooded. Pipe laying shall follow excavating as closely as possible.

3.07 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.

B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.

C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

3.08 BRANCH CONNECTIONS

A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.

B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Use of forged weld-on fittings is also limited as follows:

1. Must have at least same pressure rating as the main.
2. Header or main must be 2-1/2" or over.
3. Branch line is at least two pipe sizes under header or main size.

D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

3.09 JOINING OF PIPE

A. Threaded Joints:

1. Ream pipe ends and remove all burrs and chips.
2. Protect plated pipe and valve bodies from wrench marks when making up joints.
3. Apply gas-rated Teflon tape or thread compound to male threads.

B. Flanged Joints:

1. Steel flanges shall be raised face.
2. Bolting for services up to 500°F shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts".
3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
    a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
    b. Maximum pressure rating of at least 250 psig.
    c. Minimum temperature rating: -10°F.
    d. Maximum temperature rating of at least 170°F for water systems operating 140°F and less.

C. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

D. Fusion Weld:

1. Make all field cuts of pipe square and true using a pipe cutter designed for plastic pipe.
2. Make sure proper heating heads are used for male and female situations.
3. Bevel the leading edge of pipe section with a 45° chamfer.
4. Utilize a fusion welding tool recommended and/or provided by the pipe and fitting manufacturer.

5. Not recommended for temperatures below 40°F.
6. Follow the manufacturer's cold weather installation procedures.
7. All installers shall undergo training provided by the manufacturer or manufacturer's representative.
8. Follow all manufacturers' installation instructions.

3.10 PAINTING EXPOSED PIPE

A. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

3.11 SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators. Verify gas service pressure with the Utility Company.

END OF SECTION

SECTION 22 1030
PLUMBING SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Cleanouts.
B. Traps.
C. Trap Seals.
D. Floor Drains and Sinks
E. Hub Drains and Standpipes
F. Backflow Preventers.
G. Strainers.
H. Unions.
I. Balancing Valves.
J. Water Hammer Arresters.
K. Dielectric Fittings (Connections Between Dissimilar Metals).
L. Air Vents.
M. Drain Valves.
N. Relief Valves.
O. Compressed Air Filters.
P. Compressed Air Condensate Traps.

1.02 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500.
B. Include sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

2.01 CLEANOUTS

A. Provide cleanouts as shown and specified on the drawings as well as required by code.
B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.
C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

2.02 YARD CLEANOUTS

A. Provide yard cleanouts as shown and specified on the drawings as well as required by code.
B. Cleanout shall be same size as pipe up to 6" and 6" for larger pipes.

2.03 TRAPS

A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:

1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
2. Insulated at accessible lavatories.
3. Cast iron, deep-seal pattern where concealed above ceiling, below grade or in unfinished areas.
4. Deep-seal pattern of the same material and/or coating where drainage lines are of special materials or coatings such as polypropylene, PVDF, CPVC, etc.

B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.

C. Each trap shall be completely filled with water at the end of construction but before building turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water and a 1/2" minimum layer of mineral oil.

2.04 TRAP SEALS

A. Provide trap seals as specified on the drawings.

2.05 FLOOR DRAINS AND SINKS

A. Floor drains and sinks shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.

B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

2.06 HUB DRAINS AND STANDPIPES

A. A hub drain shall be in the form of a hub or pipe without a grate/strainer extending through the floor for receiving indirect waste. A hub drain has a flood level rim above the finished floor.

B. Provide hub drains as shown and specified on the drawings as well as required by code.

2.07 BACKFLOW PREVENTERS

A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.08 STRAINERS

A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

1. Water:
   a. 1/4" - 2": 3/64" perforations
   b. 2-1/2" - 10": 1/16" perforations
   c. 12" - 18": 1/8" perforations

B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.

C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.09 UNIONS

A. Copper pipe - wrought copper fitting - ground joint.

B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.

C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

2.10 BALANCING VALVE WITH FLOW INDICATION

A. Balancing valve with built-in visual flow meter, adjustable flow control with memory stop feature, external temperature gauge, and tight shutoff.

B. Maximum working pressure: 150 psi. Maximum Temperature 230°F. Maximum differential pressure: 15 psi. Maximum inlet temperature: 195°F.

C. Low-lead brass valve, stainless steel springs, EPDM seals.

D. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on the self-contained visual flow meter.

E. Acceptable Manufacturers:

1. Calieffi 132 Series
2. Watts CSD (provide with separate external temperature gauge)

2.11 WATER HAMMER ARRESTERS

A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.

B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100°F and 300°F and maximum 250 psig working pressure.

2.12 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron, steel, and stainless steel connected to each other.
2. Brass, copper, and bronze connected to each other.
3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.
2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.

F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.13 AIR VENTS

A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.

B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

2.14 DRAIN VALVES

A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

2.15 RELIEF VALVES

A. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

PART 3 - EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Coordinate construction to receive drains at required invert elevations.

B. Install all items per manufacturer's instructions.

C. Water Hammer Arresters:

1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.
2. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
3. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.

D. Cleanouts:

1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet in pipe less than 6" size and 100 feet apart in 6" and larger pipes inside the building. Provide cleanouts at bases of all sanitary and storm risers as shown on the drawings and as required by code.
2. Extend cleanouts to the floor with long sweep elbows.
3. Install a full size, two-way cleanout within 5 feet of the foundation inside or outside of building.
4. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
5. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.

E. Trap Seals:

1. Install trap guard on drains not receiving continuous discharge and subject to drying out.

F. Floor Drains and Floor Sinks:

1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain. Membrane is not required if upper floor construction is single pour, cast-in-place concrete.
2. Use alternate sealing method when installing drains in existing floor slabs.
3. Coordinate sloping requirements with the architectural plans and specifications.
4. Top of floor drain and sinks grate/strainer shall not extend above the finished floor elevation.
5. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised

above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.

G. Hub Drains and Standpipes:

1. The top of a hub drain/standpipe shall extend above the finished floor elevation. Refer to drawings for dimensions above the finished floor.
2. Access shall be provided to drains and standpipes for rodding.

H. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.

I. Balancing Valves:

1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION

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SECTION 22 1200
TANKS - PLUMBING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Domestic Hot Water Storage Tanks.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500. Include manufacturer's installation instructions.

B. For domestic hot water storage tanks, include tank lining instructions.

1.03 REGULATORY REQUIREMENTS

A. Construct pressurized tanks to ASME Code for unfired pressure vessels.

B. Comply with applicable government regulations.

PART 2 - PRODUCTS

2.01 DOMESTIC HOT WATER STORAGE TANKS

A. Tank: Steel, 125 psi working pressure, ASME stamped, with screwed stainless steel connections.

B. Line interior with corrosion resistant concrete approximately 1/2" thick. Line flanged connections. Clean and prime coat before lining. Lining may be factory or field applied. If factory applied, all cracks shall be repaired after installation.

C. Provide 11" x 15" access opening and steel support saddles or legs.

D. Provide tappings for accessories. Include tank drain, water inlet and outlet, 30°F to 200°F thermometer per Section 23 3100, and pressure relief valve suitable for maximum working pressure. Refer to drawings for additional tank openings.

E. Manufacturers:

1. Adamson
2. Ace Boiler
3. Modern Welding
4. RECO
5. PVI
6. Bradford White
7. Cemline.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Support indoor tanks from building structure or construct support stand.

B. Flush and clean tanks prior to delivery to site and keep sealed during construction.

C. Provide all flexible connections required due to tank flex during fill operation.

END OF SECTION

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SECTION 22 1519
COMPRESSED AIR SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Compressed Air Piping (Non-Medical)
B. Condensate Piping
C. Shutoff Valves
D. Automatic Drain Valves
E. Filter
F. Pressure Gauge
G. Flexible Connections
H. Point-of-Use Couplings
I. Compressors
J. Oil-water Separators
K. Lockout Trim
L. Valve Connections

1.02 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

1.05 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 0500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.01 COMPRESSED AIR PIPING (NON-MEDICAL)

A. Design Pressure: 125 psi; Maximum Design Temperature: 150°F
B. Piping - 2" and Under:
   1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
   2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
   3. Fittings: Wrought copper solder joint, ANSI B16.22.

2.02 CONDENSATE PIPING

A. Design Pressure: 125 psi; Maximum Design Temperature: 150°F
B. Piping - 2" and Under:
   1. Tubing: Type DWV hard drawn seamless copper tube, ASTM B306.
   2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
   3. Fittings: Wrought copper solder joint, ANSI B16.22.

2.03 SHUTOFF VALVES

A. Ball Valves:

1. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, vented, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals.
    a. Manufacturers:
        1) Apollo #77C-140
        2) Stockham #S-255-FB-P-UL
        3) Milwaukee #BA-400
        4) Watts
        5) Nibco #585-70-66
        6) National Utilities Co.
        7) RUB
    b. NOTES: Provide lockout trim for all valves.

2.04 AUTOMATIC DRAIN VALVES

A. Zero Loss Drain:

1. Electronic Operation: Electronic level control to monitor liquid level in the drain. Electronic control opens drain valve to discharge condensate and closes before compressed air is lost. 120VAC, alarm mode with visual signal and potential-free contact.
    a. Manufacturers:
        1) Gardner Denver EEDS series
        2) Parker Finite series
        3) Ingersoll-Rand ENL series
        4) Quincy Q-MAT series

2.05 FILTER

A. Particulate: Aluminum or brass body, 125 psi minimum rating, compact modular assembly, NBR seals, metal bowl with poly sight gauge, manual drain, cellulose cartridge filter capable of removing liquids and solids of 5 microns or larger, capacity shall be for rated flow of equipment ASCO Series 65X.

2.06 PRESSURE GAUGE

A. Accuracy Grade 1A (+/- 1% full range), dry for air service, with stainless steel or brass case, non-shatterable safety glass, pressure blowout back, 3-1/2" minimum diameter dial, dial range 0 psi to 200 psi, ASME B40.100 compliant.

1. Manufacturer:
    a. Ashcroft 1009

2.07 FLEXIBLE CONNECTIONS

A. Vibration isolation, wire braid reinforced corrugated metal hose type, line-sized, with bronze end connections, suitable for pressure indicated, length as recommended by manufacturer not less than 18".

B. Hose whip, rubber hose, line size, minimum 250 psi working pressure rating, brass crimped NPT fittings, 36" maximum length.

2.08 POINT-OF-USE COUPLINGS

A. Non-exhausting Type: All brass construction, 1/4" body size, 125 psi minimum working pressure rating, general purpose, manual connect, industrial interchange style, coupling shall have female NPT connection with automatic shutoff, plug shall have male NPT connection.

1. Manufacturers:
    a. Milton, Parker 20 Series
    b. Approved equal

B. Exhausting Type: All brass construction, 1/4" body size, 125 psi minimum working pressure rating, general purpose, push-to-connect, industrial interchange style, coupling shall have female NPT connection with automatic shutoff, plug shall have male NPT connection and ball check to bleed pressure from hose.

1. Manufacturers:
    a. Parker E-z-mate series

2.09 COMPRESSORS

A. Reciprocating:

1. Simplex compressor unit consisting of single-stage, splash lubricated, air-cooled motor driven compressor, integral air receiver, rubber isolators, and operating controls.
2. Compressor Construction:
    a. Construct compressor with cast iron housing and head, heat treated forged steel or ductile iron shaft, aluminum alloy connecting rods, aluminum pistons with rings, and high strength alloy suction and discharge valves. Statically and dynamically balance rotating parts.
    b. Provide oil pressure switch to shut down compressor.
    c. Mount motor and compressor on one-piece ribbed cast iron or welded steel base with provision for V belt adjustment.
    d.
3. Controls: Unit shall be provided with on/off controls.
4. Acceptable Manufacturers:
    a. Curtis
    b. Quincy
    c. Gardner-Denver
    d. Ingersoll Rand

2.10 MOTORS

A. Refer to Section 22 0513, Motors.

2.11 OIL-WATER SEPARATORS

A. Gravity based float system with replaceable filter media.

B. Filter media shall meet or exceed all requirements of state or local waste water discharge regulations.

C. Acceptable Manufacturers:

1. Curtis
2. Quincy
3. Nano
4. JORC
5. Gardner-Denver
6. Ingersoll Rand

2.12 LOCKOUT TRIM

A. Provide lockout trim for all quarter turn shutoff valves.

2.13 VALVE CONNECTIONS

A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install all products per manufacturer's recommendations.

B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

C. Remove scale and dirt on inside and outside before assembly.

D. Connect to equipment with flanges or unions.

3.02 TESTING PIPING

A. Compressed Air Piping, Condensate Piping:

1. Test piping using compressed air per ASME 31.9 requirements.
2. Test piping at 125% of normal operating pressure in accordance with ASME 31.9.
3. Piping shall hold this pressure for one hour with no drop in pressure.

3.03 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. Air Blow:

1. Blow out pipe and components with clean compressed air. Instrument air lines shall be blown out with dry, oil free air or nitrogen gas. "Oil Free" is defined as air compressed in a centrifugal, Teflon ring, carbon ring or water pumped air compressor. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedure may be used until discharge at all blowout points is clean. Use 80-90 psig pressure unless otherwise indicated.

3.04 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

6. Seal pipes passing through exterior walls with a wall seal per Section 22 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

B. Installation Requirements In Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

C. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of each equipment connection without isolating any equipment or portion of the system, unless noted otherwise.
2. Provide clearance for installation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.

3.05 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.

B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.

D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.

E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.

F. Make changes in direction of pipes only with fittings. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.

G. Provide flanges or unions at all final connections to equipment, traps and valves.

H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.

I. Use full and double lengths of pipe wherever possible.

J. Unless otherwise indicated, install all piping, including shutoff valves, filters, and regulators, to equipment at line size with reduction in size being made only at control valve or equipment.

K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.

L. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane to prevent carryover of condensate and foreign matter.

3.06 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all condensate and compressed air lines, including branches, shall pitch 1" in 40 feet in the direction of airflow to low points for complete drainage, removal of condensate.

B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.

C. Provide drip legs at low points and at the base of all risers in compressed air pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install compressed air and gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.

E. Provide air vents at high points and wherever else required to eliminate air in all condensate piping systems.

3.07 BRANCH CONNECTIONS

A. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

B. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Forged weld-on fittings are limited as follows:

1. Must have at least same pressure rating as the main.
2. Main must be 2-1/2" or larger.
3. Branch line is at least two pipe sizes under main size.

3.08 JOINING OF PIPE

A. Solder Joints:

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

END OF SECTION

SECTION 22 3000
PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Water Heaters.

B. Water Softeners.

C. Pressure Booster System.

D. Reverse Osmosis System.

1.02 QUALITY ASSURANCE

A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:

1. American Gas Association (AGA).
2. National Sanitation Foundation (NSF).
3. American Society of Mechanical Engineers (ASME).
4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
5. National Electrical Manufacturers' Association (NEMA).
6. Underwriters' Laboratories (UL).

B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested in accordance with DOE 10 CFR, ANSI Z21.10.1 and ANSI Z21.10.3.

C. Conform to ASME Section VIII for construction of water heaters and heat exchangers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500.

B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.

C. Include heat exchanger dimensions, size of tappings, and performance data.

D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

E. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.

F. Submit manufacturer's installation instructions including control and electrical power/controls wiring diagrams.

G. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.

H. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.05 REGULATORY REQUIREMENTS

A. Water heaters shall conform to AGA, ANSI/NFPA 54, ANSI/NFPA 70, ANSI/UL 1453 as applicable.

B. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.

C. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

PART 2 - PRODUCTS

2.01 WATER HEATERS

A. All water heaters shall be as scheduled on the drawings.

2.02 COMMERCIAL WATER SOFTENER

A. Automatic triplex water softener to remove hardness to no more than 1.0 grains per gallon as determined by an ASTM Standard Soap Test Method.

B. Incoming water contains approximately 21 grains per gallon based on information obtained from the local Culligan water sample.

C. System designed for 200,000 grains per 60 lbs. salt minimum and 300,000 grains per 150 lbs. salt maximum exchange capacities. Incoming water contains approximately 21 grains per gallon. Water pressure drop not to exceed 2 psi at continuous flow rate of 50 gpm per softener and 15 psi at a peak flow rate of 152 gpm; 120/1/60 power requirements.

D. Softener Tank(s): Steel, ASME constructed, ASME stamped, designed for a working pressure of 100 psig, hydrostatically tested at 150% of working pressure. Side shell height to allow a minimum freeboard space of 50% of the mineral bed depth for adequate expansion during backwashing. Tank shell of high grade steel. Softener tank not over 30 inches diameter, 60 inches side shell height. Tank shall be internally lined to help prevent corrosion. Tank supported with steel strap legs. Two 4" x 6" elliptical handholes in tanks 30" in diameter or smaller. Exterior primed and painted.

E. Distribution System: Soft water collector and backwash distributor, hub and arm radial or healer lateral type lower distribution system. Distribution shall be covered with a single layer of washed inorganic media to evenly distribute the service and backwash water and support the mineral bed tank.

F. Brine Tank: Rigid polyethylene or fiberglass with tight fitting cover, size not over 30 inches diameter, 50 inches height, corrosion-free elevated salt platform, float-operated plastic fitted brine valve to control brine withdrawal and freshwater refill. The brine valve shall provide positive shutoff to prevent air from entering the system. Brine eductor shall dilute brine flow to softener. Brine shall be provided with a float-operated shutoff valve to keep the tank from overfilling.

1. Provide initial fill of brine tank with manufacturer recommended salt product. Tank shall be full at time the Owner is given occupancy.

G. Softener Ion Exchange Resin: Virgin, high capacity, standard mesh of sulfonated polystyrene type stable over the entire PH range, with good resistance to bead fracture from attrition or osmotic shock. Minimum exchange capacity of 30,000 grains when regenerated with 15 lbs. of salt per cubic foot. Solid resin, of the proper particle size of 20 to 50 mesh, U.S. standard screen, and will contain no agglomerates, shells, plates, or other shapes to interfere with normal function of water softener. The system shall include 10 cubic feet of exchange resin per vessel and a total of 30 cubic feet of resin for the system.

H. Pipes, Valves and Fittings: Pipe shall be galvanized, standard weight steel, Type L copper, or Schedule 5 stainless steel. Fittings shall be 125 lb. Class malleable iron for steel, Type L for copper, and Schedule 5 for stainless steel. All piping shipped assembled shall be hydrostatically tested for leaks at the factory.

I. Water Testing Equipment: Complete with sample cock installed to obtain samples of effluent water. Furnish a complete test kit for conducting soap tests.

J. Automatic Controls:

1. The main control shall be a fully automatic, top-mounted brass control and sized with 3 inch NPT inlet and outlet connections. The top-mounted main control design will be motor driven, mechanically activated, with five pistons to accomplish the regeneration steps of backwash, brine draw/rinse, fast rinse, and brine refill, in addition to the service position.

2. The main control shall incorporate self-adjusting flow regulators to control the rate of flow and prevent resin loss during backwash, regardless of the system pressure fluctuations between 30 and 120 psig.

3. Valves shall be controlled by integral electronic controls. Controls shall display status of each unit with respect to service and regeneration. Controls for multi-tank systems shall be capable of operating units simultaneously, alternating unit service, or progressively bringing additional units on and off line as needed to maintain flow rates and reduce risk of channeling.
4. Regeneration shall be initiated by volume. System shall be programmed so units are unable to regenerate simultaneously.
5. Provide brine reclaim system. During regeneration cycle, a portion of the brine draw/slow rinse cycle waste will be diverted back to the brine tank using specific valve arrangements. Brine reclaim shall be automatically controlled.
6. The unit shall be supplied so that the valve will allow automatic bypass of untreated water during regeneration. The bypass shall be integral to the main control.
7. Each controller shall be provided with dry contacts that will be able to send alarms to the building automation system.
8. Electrical Requirements: Each valve shall be prewired with a plug and cord and an inline breaker to plug into a standard receptacle or wired to a common control panel so a single electrical connection can be provided. 120 volt-single phase. Electric power shall not be needed for manual regeneration. Inlet hydraulic pressure shall be required.

K. Extra Stock:

1. Furnish extra materials as listed below that match products installed and that are packaged and labeled for storage.
    a. Provide one additional gasket for each handhole and manway.

L. Warranty:

1. Provide a standard one-year warranty on the entire unit from the date of final acceptance.
2. Provide a standard two-year warranty on the control valve internal parts, the brine valve and associated parts, and the salt storage container internal components.
3. Provide a standard five-year warranty on the control valve body, fiberglass wound container(s) (if applicable), salt storage container(s) (if applicable), and epoxy lined steel conditioner tank(s) (if applicable).

M. Manufacturers:

1. Culligan
2. Marlo
3. Hellenbrand
4. Diamond
5. Siemens
6. Watts
7. Sterling
8. Avid
9. Water Control

2.03 PRESSURE BOOSTER SYSTEMS

A. Packaged pressure boosting system shall be completely factory assembled, run-tested, and shipped to site as an integral unit assembled on a steel skid including pumps, motors, valves, Type "L" copper suction and discharge manifolds, all interconnecting piping, wiring, variable frequency drives with Logic and power controls. Size and capacity shall be as scheduled on the drawings.

B. Shutoff valves shall be provided on the suction and discharge of each pump. Silent spring- loaded check valves shall be installed on the discharge of each pump.

C. Pressure gauges shall be provided on the front cover of the control panel indicating system suction and discharge pressure. Pressure gauges shall be 4-1/2 inch diameter, Grade 1A, having 1% total range span accuracy and installed with shutoff valve and pressure snubber at gauge connection to system piping. All skid-mounted components shall be factory finished with enamel paint. Individual pumps, motors, variable frequency drives, and check valves shall be serviceable with the booster system in operation, and all components shall be suitable for the maximum system working pressure.

D. System shall include three vertical mounted pumps with ANSI flanged or NPT threaded connections, replaceable casing wear rings, and hydraulically balanced impellers. Pumps shall be cast iron, bronze or stainless steel fitted construction with replaceable shaft sleeves and mechanical seals suitable for 175 psig working pressure.

E. Pressure regulating valves to control system pressure at the unit are not allowed per ASHRAE 90.1.

F. Each pump shall include a pressure relief valve, set to relieve 15 psi above the high limit pressure switch setting, which shall be piped to a floor drain by the installing contractor.

G. Provide a hydro-pneumatic tank with carbon steel or fiberglass shell and a replaceable FDA-approved, heavy-duty bladder to separate the air and water. No water shall come in contact with metal tank walls. Features shall include an air fill valve and bottom system connection suitable for 100% draw-down. Tank shall be constructed in accordance with Section VIII of the ASME code and be N.B. stamped. Refer to schedule on drawings for size. Tank shall be located remote from booster pump. Coordinate location with Architect/Engineer prior to installation.

H. Provide each pump with a premium efficient open drip-proof totally enclosed fan-cooled motor labeled for use with variable frequency drives (VFDs) and sized for operation at any point of the pump curve, including pump run-out (non-overloading operation).

I. Provide and mount on the system skid three VFDs suitable for variable torque applications. Minimum acceptable VFD full load/full speed efficiency shall be 97%, with a fundamental power factor of 0.98. VFDs shall meet the following:

1. Pulse width modulated (PWM).
2. Starts into rotating load.
3. Overcurrent protection.
4. Adjustable carrier switching frequency of up to 8 kHz.
5. Keypad operator device or touchscreen that includes the following:
    a. 2-line backlit display.
    b. Power on and alarm/fault indicators
    c. Hand-Off-Auto switch on VFD front panel cover
    d. When switched to "Auto" operation, the VFDs shall follow the signal from the control panel logic section.
    e. When switched to "Hand", the VFD speed is determined by the setting of the manual speed adjustment located on the VFD front panel cover.
    f. Automatic VFD shutdown for electrical fault
    g. Automatic restart after electrical power is restored from a loss of power
    h. Service diagnostics with fault history log.

J. Provide a high limit pressure switch compatible with the system controls, temperature, and pressure requirements. The pressure switch shall be mounted and wired on the control panel, with sensing line connected to the system discharge manifold. The high limit pressure switch shall shut down the system if the system pressure is more than 30 psi above the normal operating pressure.

K. Provide a pressure sensor/transmitter, shipped loose for field installation, that provides a modulating output compatible with the system controls. The pressure sensor/transmitter shall be used to control booster pump VFDs to maintain a constant system pressure.

L. Provide a factory-mounted pressure sensor/transmitter in the discharge header that provides a modulating output compatible with the system controls. The pressure sensor/transmitter shall be used to control booster pump VFDs to maintain a constant system pressure. Control logic shall be capable of adjusting the pressure setpoint using a system pressure drop algorithm based on real-time flow data.

M. Use of a single pressure sensor/transmitter to control system pressure and high limit pressure cutoff is not acceptable. Both the high limit pressure switch and the pressure sensor/transmitter shall be separately wired back to the booster pump control panel.

N. The lead pump shall run only as necessary to maintain system pressure and will be automatically controlled by means of a pressure sensor/transmitter and control programming to prevent short cycling.

O. If the lead pump is unable to maintain system pressure at the pressure sensor/transmitter, the lag pump will be called on after a time delay and will operate in parallel with the lead pump in accordance with control programming. When a low or no-flow condition is reached, the controls will shut down the lag pump if running and accelerate the lead pump to charge the system and hydro-pneumatic tank to 20 psi above normal operating pressure, then shut the lead pump down and alternate. Should any pump fail to operate, the next pump in sequence shall start automatically.

P. Provide, mount and wire on the skid a programmable logic controller in a NEMA 1 enclosure. The controller shall interface the signals from the sensors to the VFDs and shall provide a stabilized response to speed up or slow down the pump or add additional pumps to meet system requirements. The controller shall provide setpoint control that can be changed by a keypad entry on the control faceplate. The controller shall have an alpha/numeric display, PID functions and both system and controller self-diagnostics. Controller shall be provided with dual function PID loop for startup mode and normal operation. Startup mode shall provide a quick response from shutdown and normal operation is tuned to eliminate hunting. Controller shall have a real-time calendar/clock and memory transfer cartridge.

Q. Provide a UL listed control panel in a NEMA 12 enclosure, factory mounted and wired on the steel skid. The panel shall be furnished with individual pump disconnects with through-the-door handles, pump run lights, H-O-A selector switches, 120-volt fused control transformer, and necessary relays, timers and a programmable controller with pump start, stop and sequence controls.

R. The controller shall be capable of outputting system pressure and a general alarm signal to the building automation system.

S. Non-mercury low pressure control to stop pump operation if incoming water pressure drops to atmospheric.

T. Size and capacity shall be as scheduled on the drawings.

U. Manufacturers:

1. Xylem B&G
2. Grundfos
3. Goulds
4. Metropolitan
5. HYFAB
6. QuantumFlo
7. or approved equivalent

2.04 REVERSE OSMOSIS SYSTEM

A. Complete reverse osmosis system complete with modules, control system and prefilter.

B. The system shall be able to reduce the total dissolved mineral salt content from the water supply. The system shall be capable, upon start up, of reducing the dissolved mineral content of the water by at least 99.01% (nominal rejection), based on membrane industry design standards, when the system is operated in accordance with the operating instructions.

C. The system will be capable of supplying 3342 gallons per day (gpd) of treated water.

D. Influent Water Analysis
   1. Total Hardness - 21 gpg as CaCO3
   2. Total Dissolved Solids, TDS - 410
   3. Iron,0 ppm
   4. 55°F water temperature

E. Design parameters:
   1. Nominal Capacity: 3342 gpd
   2. Approximate Recovery: 50 gpd
   3. Daily water usage: 3342 gpd
   4. Motor, hp: 2
   5. Operating Temperature Range: 33-100°F
   6. Maximum Operating Pressure (Pump): 120-150 psi
   7. Operating Pressure Range (System): 20-50 psi
   8. Inlet Pressure (dynamic): 20-50 psi.
   9. Electrical Requirements: 208-230/60/3
   10. System Dimension: 21 x 31 x 56 inches

F. Effluent Water Quality - Initial effluent water quality based on the analysis is estimated to be 6.64 mg/l TDS

G. Prefilter: The equipment will include one (1) replaceable element type prefilter. Each filter housing will be of polypropylene construction and will contain one (1) prefilter cartridge. Each filter cartridge will be of polypropylene construction and rated at 5 microns nominal to assure maximum protection of the pump and modules.

H. Pump: One pump and motor assembly will be provided to boost the incoming water to an operating pressure of 140.0 psig. Each pump will be close coupled to a 2 HP electrical motor operating at 208-230/60/3.

I. Modules: The unit will use spiral wound reverse osmosis modules. The (2), 4" x 40" (diameter x length) modules will be the polyamide thin film composite membrane type. The module array will be capable, upon initial startup, of producing water at a nominal flow of 3342 gpd based on Culligan equipment specifications as outlined in paragraph 3.2. The module assembly will consist of 2 single element housing(s) in an array arrangement to deliver the design capacity with minimal waste flow requirements. The housings will be constructed of fiberglass (FRP) for corrosion resistance.

J. Pipe and Fittings
   1. The equipment will include all mechanical, hydraulic and electrical controls for a complete, self-contained unit. A 3/4 inch normally closed solenoid valve will be mounted on the inlet to shut off the water supply when the unit is not operating.
   2. Operating Pressure Control Valve: Operating pressure will be controlled by a panel mounted needle-type high pressure control valve connected to the waste line of the modules. It will be constructed of corrosion resistant materials and be equipped with a knob for setting the operating pressure.
   3. Waste Restrictor: A panel mounted combination flow indicator/throttling valve will be connected to the concentrate return to display and maintain the proper recovery ratio of product-to-feed water flow.
   4. Pressure Gauge(s): One liquid filled pressure gauge will be included. The gauge will indicate the operating pressure of the unit over the range of 0 to 400.0 psi.
   5. Flow Indicators: Two inline flow meters will be included to show the rate of product flow and the rate of waste flow which can be viewed on the control panel display.

6. Hydraulic Connections: The system will be designed with a 3/4 NPT connection to the inlet of the prefilter and a 3/4 NPT connection from the prefilter to the feed connection on the unit. The product water connection will be 1/2 NPT. The concentrate water connection will be 1/2 NPT.
7. Mounting: The control assembly, pump assembly, and module assembly are mounted to a rigid 3 to 11 gauge powder coated steel frame and are completely pre-plumbed.

K. Electrical Controls

1. An electronic controller will be utilized to control the logical operation of the unit. A menu driven program operated by a sealed keypad will be used to program the system options. Operational data, such as TDS in/out, percent rejection, feed and product flow, totalized product flow, pumping time and percent recovery, will be displayed on a multi-line OLED display viewable on the front of the enclosure door. Additionally, the controller retains historical operating data which can be used to determine maintenance needs. The display shows messages which indicate if the unit is currently making water, offline, or in a standby mode because of a full storage tank or pre-treatment lock-out condition. If the unit detects that an error has occurred, a short description of the error will display at the push of a keypad button.
2. Connections will be provided to allow easy installation of an optional level control or pressure switch, which will shut down the system and prevent overflow or overpressurizing of an optional product water storage tank. An adjustable pressure sensing switch is installed after the inlet solenoid to protect the pressure pump from cavitation by shutting down the pump and inlet solenoid should the inlet pressure fall below 22.5 psig for more than 3 seconds. An alarm output signal (24VAC, 500mA) is provided for connection to an external alarm.
3. Connections will be provided to allow simplified wiring of an external signal switch, which will shut down the inlet solenoid and pressure pump during the regeneration cycle of pretreatment equipment to prevent untreated water from entering the reverse osmosis system. The system will start automatically when the pretreatment equipment has finished regeneration.
4. The controller includes monitoring of feed and product TDS. The TDS alarm level shall be user adjustable to signal when quality falls below the desired level. A second alarm level allows specification of minimum acceptable rejection percentage.
5. The controller includes monitoring of feed and product flow rates. The flow rates can be used to set high and low alarms based on percentage recovery.
6. The electronic controller shall include a modem device which can be used with an optional telemetry service which allows the unit to record daily operating conditions. The telemetry service also provides for immediate email notification if the system should shut down for any alarm condition.
7. A connection will be provided to allow the use of an external monitoring device using USB, RS232 or RS485 protocols.

L. Field Service: The services of a factory authorized service representative can be made available to supervise, inspect and provide operator training as required for initial start-up and system operation. Contact your local Culligan dealer for service rates and scheduling.

M. Manufacturers:

1. Culligan (G2-2HE),
2. Total Water
3. US Water
4. Water Control
5. Evoqua
6. Chem-Aqua
7. Marcor
8. Marlo Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all items in accordance with manufacturer's instructions.

3.02 WATER HEATER INSTALLATION

A. Install water heaters on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 22 0529.

B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.

D. Install gas water heaters according to NFPA 54.

3.03 WATER SOFTENER INSTALLATION

A. Verify connection sizes and piping type with cold water and soft cold water piping. Provide dielectric connection between dissimilar metals. Pressure gauges are required at hard water inlet and soft water outlet of each softener.

B. Provide system start-up and subsequent service, with stocking of spare parts by authorized dealer or factory trained personnel.

C. Provide complete instructions covering installation and operation of the softening system in booklet form. All components shall be easily identified, in exploded views, by individual part number.

D. Provide six hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers shall be included in training.

3.04 PRESSURE BOOSTER INSTALLATION

A. Provide startup by factory authorized start-up technician.

B. Mount pressure sensor/transmitter used to control pressure booster pump VFDs remote from booster pump skid near the most remote critical plumbing fixture as indicated on the drawings, and wire signal directly back to pressure booster control panel. Pressure sensor/transmitter signal shall not interface with or be transmitted across any building information system network. Provide signal amplifiers or repeaters as required to ensure proper control operation.

C. Provide four (4) hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers, shall be included in the training.

D. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger.

E. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.

F. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.

G. Unless otherwise shown on the drawings, mount all pump skids on 4" high concrete pads and anchor frames to pads with cast-in-place anchors.

H. All pump skids shall be grouted in. Follow manufacturer's instructions for grouting.

I. Install on vibration isolators as scheduled on drawings.

J. Coordinate installation to ensure manufacturer's recommended service clearances are met.

3.05 REVERSE OSMOSIS SYSTEM

A. Install reverse osmosis system on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 22 0529.

B. Field Service: The services of a factory authorized service representative can be made available to supervise, inspect and provide operator training as required for initial start-up and system operation. Contact your local Culligan dealer for service rates and scheduling.

C. Provide complete instructions covering installation and operation of the reverse osmosis system in booklet form. All components shall be easily identified, in exploded views, by individual part number.

D. Provide four (4) hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers, shall be included in the training.

END OF SECTION

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SECTION 22 4000
PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. All plumbing fixtures.

1.02 SUBMITTALS

A. Submit product data under provisions of Section 22 0500. Submittals shall include fixture carriers for record purposes only. Architect/Engineer does not review or approve carriers except for manufacturer.

B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. For fixtures and trim requiring electrical connections, submit product data indicating general assembly, components, electrical power/controls wiring diagrams, and service connections.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Wall Hung Fixture Carriers:

1. Material: All Metal, ASME/ANSI A112.6.1M.
2. Manufacturers:
    a. Zurn
    b. Smith
    c. Wade
    d. Josam
    e. Watts
    f. Mifab.
3. Water closet carrier shall be rated to support 500 lbs. unless noted otherwise on the drawings.

B. All fixtures shall be as scheduled on the drawings.

C. All china shall be from the same manufacturer where possible.

D. All lavatory and sink trim shall be from the same manufacturer where possible.

E. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:

1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
2. Install each fixture with trap easily removable for servicing and cleaning. Use screwed tailpiece couplings. Connect fixture waste to stack with slip fitting.
3. Provide fixtures with chrome plated rigid or flexible supplies, loose key stops, reducers, and escutcheons.
4. Install components level and plumb.
5. Caulk joint between finish floor and floor mounted fixtures and between finish walls and wall mounted fixtures with silicon caulk. Caulk the joint, between rim and fixture where a fixture builds into a counter top, with caulking compound. Refer to DIVISION 7 for "Caulking" requirements. Color to match fixture.
6. Where there is a possibility of water following pipe brackets, etc., into a wall; caulk escutcheons, space around brackets, etc., to exclude water. Refer to DIVISION 7 for "Caulking" requirements.

7. Refer to architectural drawings for fixture mounting heights.
8. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.

B. Wall-Mounted Fixture Requirements:

1. All wall-mounted fixtures shall have compatible carriers designed for their intended service and suitable for the space available and configuration of fixtures. All carriers shall extend to the floor and be anchored to the slab.

C. Floor-Mounted Fixture Requirements:

1. Where floor mounted fixtures are installed on a sloped floor, the open void below the fixture shall be grouted, leveled, and caulked to eliminate stress on the fixture and to prevent water migration to the floor below.

D. Exposed or Inside Accessible Cabinets Traps, Valve and Pipe Requirements:

1. All traps exposed under fixtures or inside accessible cabinets shall be chrome plated brass.
2. All water or waste piping for plumbing fixtures that is exposed or inside cabinets shall be chrome plated.
3. All exposed flush valves for water closets and urinals shall have a chrome plated hanger to anchor the piping to the wall.
4. All exposed water supply piping and fittings in a finished space to a shower valve, hose bibb, or other water outlet shall be chrome plated.

E. ADA Accessible Exposed Sink and Lavatory Trim:

1. All exposed sink and lavatory traps, piping and angle stops installed at accessible sink and lavatory locations shall include offset style drain tailpiece, p-trap installed near and parallel with back wall, and insulation kit specially manufactured for this installation. Armaflex with duct tape is not acceptable.

F. ADA Accessible Water Closet Requirements:

1. Handicapped accessible water closet flush valve handles shall face the center of the stall.
2. Coordinate flush valves in handicap accessible locations with grab bars installed by the other Trade Contractors. Make modifications as necessary to flush valve piping to avoid conflict with grab bars. Common solutions include shortened or offset vacuum breaker tailpieces.

3.02 ADJUSTING AND CLEANING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion, clean plumbing fixtures, equipment, and faucet aerator screens.

3.03 FIXTURE ROUGH-IN SCHEDULE

A. Rough-in fixture piping connections in accordance with table on plumbing drawings of minimum sizes for particular fixtures.

END OF SECTION

SECTION 23 0500
BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 23 Sections. Also refer to Division 01 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the bid documents and/or Construction Manager's scope statements for complete scope of work description.

D. Scope of Work:

1. Plumbing Work: Refer to Section 22 0500 "Basic Plumbing Requirements".
2. Heating Work shall include, but is not necessarily limited to:
    a. Extend existing heating water system including pumps, piping, insulation, air control equipment, terminal heating equipment, and specialties. Make final connections to all coils, including those furnished by others.
    b. Furnish and install refrigerant piping, accessories, and final charge of refrigerant.
    c. Furnish and install condensate drain piping from cooling related equipment such as air handlers and cooling coil drain pans.
    d. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work. Refer to 07 8400.
    e. Complete all applicable tests, certifications, forms, and matrices.
3. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:
    a. Furnish and install package indoor air handling units complete with dampers, filters, coils, fans, and motors.
    b. Furnish and install air-cooled condensing units and curbs.
    c. Furnish and install complete supply air ductwork systems including all fittings, insulation, and outlets.
    d. Furnish and install complete return air ductwork systems including all fittings, insulation, and inlets.
    e. Furnish and install all terminal air boxes and reheat coils.
    f. Furnish and install combustion ductwork.
    g. Furnish and install complete exhaust ductwork systems including all fittings, insulation, inlets, and fans.
    h. Furnish and install mechanical room ventilation systems including louvers, ductwork, insulation, and fans.
    i. Furnish and install gas flues, stacks, and breechings.
    j. Furnish and install all temperature control systems.
    k. Complete all applicable tests, certifications, forms, and matrices.
4. Fire Protection Work: Refer to Section 21 0500 "Basic Fire Suppression Requirements".

5. Testing, Adjusting, and Balancing Work shall include, but is not necessarily limited to:
    a. Furnish complete testing, adjusting, and balancing as specified in Section 23 0593, including, but not limited to, air systems, hydronic systems, plumbing systems, and verification of control systems.
    b. Complete all applicable tests, certifications, forms, and matrices

1.03 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. The Owner reserves the right to determine when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 ALTERNATES

A. Bakery Equipment: Rough-ins are part of the Base Bid.

B. Laundry Equipment: Rough-ins are part of Base Bid where noted on the drawings.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
    a. Plumbing Contractor.
    b. Heating Contractor.
    c. Air Conditioning and Ventilating Contractor.
    d. Temperature Control Contractor.
    e. Fire Protection Contractor.
    f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
    a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
    a. Light fixtures.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
    a. Burners.
    b. Condensing Units.
    c. Gas Trains.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.

3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:
1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    a. Scale of drawings:
        1) General plans: 1/4 Inch = 1'-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
        4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
        5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:
1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa's Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.

F. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.

8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
    a. Any item listed as furnished shall also be installed, unless otherwise noted.
    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:
1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:
1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.
1. Submittals List:

Referenced Specification Section	Submittal Item
23 05 00	Owner Training Agenda
23 05 13	Motors
23 05 29	Hangers and Supports
23 05 29	Prefabricated Curbs
23 05 48	Vibration Isolation Equipment
23 05 53	HVAC Identification
23 05 93	Testing, Adjusting, and Balancing
23 07 13	Duct Insulation
23 07 19	HVAC Pipe Insulation
23 09 00	Controls
23 09 13	Instrumentation
23 23 00	Refrigeration Piping and Specialties

Referenced Specification Section	Submittal Item
23 31 00	Ductwork
23 31 00	Ductwork Layout Drawings
23 31 00	Duct Specialties (such as Turning Vanes)
23 33 00	Duct Silencers
23 34 23	Power Ventilators
23 34 23	Prefabricated Curbs
23 36 00	Terminal Air Boxes
23 37 00	Grilles, Registers, and Diffusers
23 37 00	Louvers
23 40 00	Filters and Filter Systems
23 62 13	Condensing Units
23 73 13	Indoor Modular Air Handling Units
23 82 00	Terminal Heat Transfer Equipment
23 82 16	Coils

B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:
   1. Transmittal: Each transmittal shall include the following:
      a. Date
      b. Project title and number
      c. Contractor's name and address
      d. Division of work (e.g., plumbing, heating, ventilating, etc.)
      e. Description of items submitted and relevant specification number
      f. Notations of deviations from the contract documents
      g. Other pertinent data
   2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
      a. Date
      b. Project title and number
      c. Architect/Engineer
      d. Contractor and subcontractors' names and addresses
      e. Supplier and manufacturer's names and addresses
      f. Division of work (e.g., plumbing, heating, ventilating, etc.)
      g. Description of item submitted (using project nomenclature) and relevant specification number
      h. Notations of deviations from the contract documents
      i. Other pertinent data
      j. Provide space for Contractor's review stamps
   3. Composition:
      a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions. or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 23 XX XX.description.YYYYMMDD
    b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
1. Condensing Units

B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

C. Coordinate the installation of heavy and large equipment with all Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.16 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 23 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Covering exterior walls, interior partitions and chases.
2. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    a. Pipe insulation is installed and fully sealed.
    b. Pipe and duct wall penetrations are sealed.
    c. Pipe identification and valve tags are installed.
    d. Main, branch and flexible ducts are installed.
    e. Diffusers, registers and grilles are installed and connected to ductwork.
    f. Terminal air box control wiring is complete and all control boxes are closed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.03 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.04 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div23.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, one paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" (12mm) thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Refer to Section 23 0900 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.

15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

3.05 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Explanation of all air handling systems.
3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
4. Maintenance of equipment.
5. Smoke control systems.
6. Stairwell pressurization systems.
7. Start-up procedures for all major equipment.
8. Explanation of seasonal system changes.
9. Description of emergency system operation.

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

F. Minimum hours of instruction for each item shall be:

1. Refrigeration System - 2 hours.
2. Air Handling System(s) - 4 hours.
3. Exhaust System(s) - 2 hours.
4. Temperature Controls - As defined in Section 23 0900.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.06 SYSTEM STARTING AND ADJUSTING

A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.

D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.

E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.07 RECORD DOCUMENTS

A. The following paragraphs supplement Division 01 requirements.

B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Refer to Section 23 0900 for additional requirements for Temperature Control documents.

E. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

F. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

G. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

H. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.08 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

B. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

C. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.

3.09 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Refer to Division 00 and Division 01 specifications for additional requirements which may include special requirements for work within the correctional facility.

3.11 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION

A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, air handling units, fans, terminal air boxes, fan coil units, cabinet heaters, blower coils, and the like.

B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.

C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.

D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.

E. The following steps shall be taken during testing, adjusting, and balancing of each air system:

1. All construction activities in all spaces served by the air system shall stop.
2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.
3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.
4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.

F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. All air handling units operating and balanced.
2. All fans shall be operating and balanced.
3. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
4. All temperature control systems operating, programmed and calibrated.
5. Pipe insulation complete, pipes labeled, and valves tagged.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

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SECTION 23 0505
HVAC DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Mechanical demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.02 PREPARATION

A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

C. Existing Heating System: Maintain existing system in service until new system is complete and ready for service. Drain system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before partially or completely draining system. Minimize outage duration.

3.03 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned ducts and piping to source of supply and/or main lines.

D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

H. Remove unused sections of supply and return air ductwork back to mains. Patch opening with sheet metal and seal airtight. Patch existing insulation to match existing. Where existing ductwork is to be capped and reused, locate the end cap within 6" of the last branch. End caps shall be 3" pressure class and seal class "A".

I. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.04 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 23 0529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.06 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 23 0513
MOTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single Phase and Three Phase Electric Motors.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.

B. Submit shop drawings for all three phase motors.

C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.

D. Submit shaft grounding rings or brushes or ceramic bearings for all motors as required.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories.

PART 2 - PRODUCTS

2.01 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. Design motors for continuous operation in 40ºC environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.

D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.

F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.

G. Each contractor shall set all motors furnished by him.

H. All motors shall have a minimum service factor of 1.15.

I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.

J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.

K. Aluminum end housings are not permitted on motors 15 HP or larger.

L. Motor Driven Equipment:

1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.

2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Slide bases shall conform to NEMA standards.

N. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

2.02 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

A. All motors, unless exempted by EPAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
HP	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0

B. Motor nameplate shall be noted with the above ratings.

2.03 MOTORS ON VARIABLE FREQUENCY DRIVES

A. All motors driven by VFDs shall be premium efficiency type.

B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.

D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.

1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.

2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

2.04 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust, if necessary, during the first day of operation and again after 80 hours of operation.

END OF SECTION

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SECTION 23 0529
HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.02 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 0500. Include plastic pipe manufacturers' support spacing requirements.

1.03 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to Division 3 Contractor for placement into formwork.

PART 2 - PRODUCTS

2.01 HANGER RODS

A. Hanger rods for single rod hangers shall conform to the following:

	Hanger Rod Diameter	
Pipe Size	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"
6"	3/4"	5/8"

Column #1: Steel pipe.

Column #2: Copper pipe.

B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.02 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).

2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate

expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

1) Cooper/B-Line Fig B3373 Series

2) Erico 510 Series

3) Nibco/Tolco Fig. 82

2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

a. Products:

1) Mason RBA, RCA or RDA

2) Mason BR

3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.

a. Products:

1) Pipeshields E100

4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.

5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.

2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.

3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.

4. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

a. Products:

1) Anvil Fig. 160, 161, 162, 163, 164, 165

2) Cooper/B-Line Fig. 3160, 3161, 3162, 3163, 3164, 3165

3) Erico Model 630, 631, 632, 633, 634, 635

4) Nibco/Tolco Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4

5. Unless otherwise indicated, hangers shall be as follows:

a. Clevis Type: Service: Bare Metal Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and Smaller:

1) Products: Bare Steel, Plastic or Insulated Pipe:

a) Anvil Fig. 260

b) Cooper/B-Line Fig. 3100

c) Erico Model 400
d) Nibco/Tolco Fig. 1

2) Products: Bare Copper Pipe:
a) Cooper/B-Line Fig. B3100C
b) Nibco/Tolco Fig. 81PVC

b. Continuous Channel with Clevis Type: Service: Soft Copper Tubing:
1) Products:
a) Cooper/B-Line Fig. B3106, with Fig. B3106V
b) Erico Model 104, with Model 104V
c) Nibco/Tolco Fig. 1V

c. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller:
1) Products: Bare Steel Pipe:
a) Anvil Fig. 69
b) Cooper/B-Line Fig. B3170NF
c) Erico Model FCN
d) Nibco/Tolco Fig. 200.

2) Products: Bare Copper Pipe:
a) Cooper/B-Line Fig. B3170CTC
b) Erico 102A0 Series
c) Nibco/Tolco Fig. 203

6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
a. Clamp Type: Service: Bare Metal Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller:
1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
3) Products: Bare Steel or Insulated Pipe:
a) Unistrut Fig. P1100 or P2500
b) Cooper/B-Line Fig. B2000 or B2400
c) Nibco/Tolco Fig. A-14 or 2STR

4) Products: Bare Copper Pipe:
a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):

1) Products:

a) Anvil Fig. 92

b) Cooper/B-Line Fig. B3033/B3034

c) Erico Model 300

d) Nibco/Tolco 68

b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

1) Products:

a) Anvil Fig. 228, 292

b) Cooper/B-Line Fig. B3054

c) Erico Model 360

d) Nibco/Tolco Fig. 329

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

1) Products:

a) MCL. M1, M2 or M3

d. Concrete: Inserts Single Rod Galvanized:

1) Products:

a) Anvil Fig. 282

b) Cooper/B-Line Fig. B3014

c) Erico Model 355

d) Nibco/Tolco Fig. 310

e. Concrete: Inserts Continuous Strip Galvanized:

1) Products:

a) Unistrut Corp P3200 Series

b) Cooper/B-Line Fig. B22-J

c) Erico CONCT

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

g. Steel Structure Welding:

1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.03 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.

2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days (be 20 MPa strength).
4. Equipment requiring bases is as follows:
   a. Air Handling Unit

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.04 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the Division 3 Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150°F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

2.05 ROOF PENETRATIONS

A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for duct penetrations. Refer to drawings for details.

B. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: Black shall match roofing material.

C. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

2.06 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.

F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

G. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.07 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.08 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.09 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.10 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.01 HVAC SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    a. The hanger is attached within 6" from a web/chord joint.
    b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Steel (Std. Weight or Heavier - Liquid Service):
    a. Maximum Spacing:
        1) 1-1/4" & under: 7'-0"
        2) 1-1/2": 9'-0"
        3) 2": 10'-0"
        4) 2-1/2": 11'-0"
        5) 3": 12'-0"
        6) 4" & larger: 12'-0"
2. Steel (Std. Weight or Heavier - Vapor Service):
    a. Maximum Spacing:
        1) 1-1/4" and under: 9'-0"
        2) 1-1/2": 12'-0"
        3) 2" & larger: 12'-0"
3. Hard Drawn Copper & Brass (Liquid Service):
    a. Maximum Spacing:
        1) 3/4" and under: 5'-0"
        2) 1": 6'-0"
        3) 1-1/4": 7'-0"
        4) 1-1/2" 8'-0"
        5) 2": 8'-0"
        6) 2-1/2": 9'-0"
        7) 3": 10'-0"
        8) 4": 12'-0"
        9) 6": 12'-0"
4. Hard Drawn Copper & Brass (Vapor Service):
    a. Maximum Spacing:
        1) 3/4" & under: 7'-0"
        2) 1": 8'-0"
        3) 1-1/4": 9'-0"
        4) 1-1/2": 10'-0"
        5) 2": 11'-0"
        6) 2-1/2" & larger: 12'-0"
5. Soft Copper Tubing:
    a. Continuous channel with hangers maximum 8'-0" OC.

I. Installation of hangers shall conform to MSS SP-58, -69, and -89.

END OF SECTION

SECTION 23 0530
ROOF SUPPORT AND WIND BRACING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wind Restraint of Rooftop Equipment

B. Rooftop Pipe Support

C. Rooftop Equipment Support

1.02 QUALITY ASSURANCE

A. General:

1. The Contractor shall retain a specialty consultant or equipment manufacturer to develop a wind restraint and support system and perform wind restraint calculations in accordance with these specifications, state, and local codes.
2. These requirements are beyond those listed in Section 23 0550 of these specifications. Where a conflict arises between the wind restraint of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this section.
2. Equipment: Each company providing equipment that must meet wind restraint requirements shall provide certification included in project submittals that the equipment supplied for the project meets or exceeds the wind restraint of the project.

C. Installer: Installed by Contractor.

1.03 REFERENCES

A. International Building Code 2015

B. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13

C. ASCE 7-10, Chapter 29

1.04 SUBMITTALS

A. Submit under provisions of Section 23 0500.

B. Shop Drawings:

1. Coordination Drawings: Plans and sections drawn to scale, coordinating wind restraint bracing of mechanical components with other systems and equipment in the vicinity, including other wind restraint restraints.
2. Manufacturer's Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
3. System Supports/Restraints - Submit for each condition requiring wind restraint bracing:
    a. Calculations for each wind restraint brace and detail used on the project.
    b. Plan drawings showing locations and types of wind restraint braces on contractor fabrication/installation drawings.
    c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
    d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

4. Equipment - Submit for each piece of equipment supplied:
    a. Certification that the equipment supplied for the project meets or exceeds the wind restraint requirements specified.
    b. Specific details of wind restraint design features of equipment and maximum wind restraint loads imparted to the structural support.
    c. Engineering calculations and details for equipment anchorage and support structure.

C. A wind restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If wind restraint restraints are not provided for a system that requires wind restraint bracing, the wind restraint designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, used for each item. Wind restraint designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance with the exception.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.06 DESIGN REQUIREMENTS

A. This project is subject to the wind loading requirements of the International Building Code 2015 edition.

B. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

1.07 COORDINATION

A. Coordinate layout and installation of anchoring with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

1.08 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.01 SUPPLIERS

A. Miro Industries

B. Engineer pre-approved equal

2.02 DESIGN CRITERIA

A. The following design criteria applies to all equipment noted below.

B. General Information:
    1. Adopted Building Code: IBC2015
    2. Building Occupancy Risk Category: III

C. Wind Design Criteria:
    1. Mean Roof Height: 17.5 feet
    2. Basic Wind Speed: 120 MPH @ 3-second gust
    3. Exposure Category: C

2.03 ROOF PIPING SUPPORTS

A. Non-Penetrating Pillow Block Supports:
    1. Provide pre-fabricated non-penetrating pillow block roof pipe supports for all piping installed on the roof.
    2. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.

3. Acceptable Products:
    a. Anvil International HBS-Base Series
    b. Cooper B-Line Dura-Blok
    c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load)
    d. Miro Industries 1.5, 3-R, 4-R or 5-R (to match pipe)

B. Premanufactured Anchored Roof Pipe Supports:
1. Roof duct support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop piping system for uplift and lateral loading.
2. Refer to drawings for pipe size, layout, structural framing, roofing material, and wind loading information.
3. Provide adjustable pre-fabricated pipe supports for all pipe installed on the roof. Supports include a combination of non-penetrating pillow block pipe supports and stanchioned supports anchored to the roof structure.
    a. Supports shall be constructed from hot dipped galvanized steel minimum 12-gauge channel or tube steel. Manufacturer shall determine final design.
4. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
5. Acceptable Manufacturer:
    a. Miro Industries DS and Stanchioned DS

2.04 ROOF EQUIPMENT SUPPORTS

A. Equipment Roof Curbs and Rails:
1. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.
2. Refer to drawings for equipment size, layout, structural framing, roofing material, and wind speed.
3. Provide adjustable prefabricated roof equipment supports for all equipment installed on the roof. Supports include stanchioned supports anchored to the roof structure.
4. Equipment requiring curbs or rails with this section is as follows:
    a. Condensing units
    b.
5. Provide prefabricated curbs or rails as follows:
    a. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
    b. 14 or 18 gauge galvanized sheet metal, as required for the equipment weight.
    c. Internal reinforcing.
    d. Pressure treated wood nailer.
    e. 18 gauge counter flashing completely covering nailer.
    f. Factory insulated with rigid fiberglass.
6. Refer to drawings for curb and rail heights.
7. Match units to the building roof with either a raised cant to match roof insulation (for built-up roofs) or with no cant (for single-ply roofs).
8. Where legs of equipment rest on rails, provide 1/4" bent plates 18" long.
9. Manufacturers:
    a. Thy
    b. Pate

c. United
d. Roof Products Systems
e. Portals Plus

B. Exhaust Fans, Roof Hoods, Etc.:
1. Curb provided with equipment. Rooftop equipment such as roof hoods and rooftop exhaust fans shall be provided with curbs by the unit manufacturer. Refer to individual equipment sections for curb description.
2. This section shall provide anchoring such as guy wires, tethers, or straps to limit wind disruption.
3. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all items per manufacturer's instructions.
B. All wind restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
C. Installation of wind restraints shall not cause any change in position of equipment, piping, or ductwork resulting in stresses or misalignment.
D. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
E. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast-in-place inserts.
F. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only. Do not install cables over sharp corners.
G. Provide reinforced clevis bolts when required.
H. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.
I. Positively attach all roof-mounted equipment to roof curbs. Positively attach all roof curbs to building structure.
J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
K. Supports shall extend directly to building structure.
L. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the drawings as being by others.
M. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
N. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.

3.02 ROOF PIPING SUPPORTS

A. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.
B. Install roof pipe supports to resist wind movement per manufacturer's recommendations. Method of securing base to roof shall be compatible with roofing materials.
C. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.
D. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories, to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

E. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

F. Support piping at equipment and valves so it can be disconnected and removed without further supporting the piping.

G. Piping shall not introduce strains or distortion to connected equipment.

H. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, and at equipment connections and heavy fittings.

I. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

J. Spacing: Refer to Supports and Anchors section for pipe spacing requirements.

3.03 INSPECTION

A. Special inspection and testing shall be done in accordance with Chapter 17 of the International Building Code.

B. The Contractor shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, and the Engineer of Record. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

END OF SECTION

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SECTION 23 0548
HVAC VIBRATION ISOLATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Bases.

B. Vibration Isolation.

C. Flexible Connectors.

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500 and the Vibration Isolation Submittal Form at the end of this section.

B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.

C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.

D. Isolator submittals shall include:

1. Equipment served
2. Type of Isolator
3. Load in Pounds per Isolator
4. Recommended Maximum Load for Isolator
5. Spring Constants of Isolators (for Spring Isolators)
6. Load vs. Deflection Curves (for Neoprene Isolators)
7. Specified Deflection
8. Deflection to Solid (at least 150% of calculated deflection)
9. Loaded (Operating) Deflection
10. Free Height
11. Loaded Height
12. Kx/Ky (horizontal to vertical stiffness ratio - for spring isolators)
13. Materials and Coatings
14. Spring Diameters

E. Make separate calculations for each isolator on equipment where the load is not equally distributed.

F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

PART 2 - PRODUCTS

2.01 BASIC CONSTRUCTION AND REQUIREMENT

A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

C. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

E. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

F. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.

G. Provide motor slide rails for belt-driven equipment per Section 23 0513.

H. All isolators shall have provision for leveling.

2.02 MOUNTINGS

A. Type M2:

1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.
    a. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.
2. All units shall have bolt holes and be bolted down.
3. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.
4. Manufacturers:
    a. Mason Industries "ND" or "DNR"
    b. Amber/Booth "RVD"
    c. Kinetics "RD"
    d. Vibration Mountings and Controls "RD"
    e. Vibration Eliminator Co. "T22" or "T44"

B. Type M4:

1. Use restrained spring mountings for equipment with operating weight different from the installed weight such as chillers and boilers, and equipment exposed to the wind such as cooling towers.
2. Spring isolators shall be free-standing with 1/4" neoprene acoustical friction pads.
3. All units shall have bolt holes and be bolted down. Prevent short circuiting with neoprene bushings and washers between bolts and isolators.
4. All mountings shall have leveling bolts.
5. Housings with vertical resilient limit stops shall prevent spring extension when weight is removed. Housings shall serve as blocking during erection and the installed and operating heights shall be the same.
6. Maintain a minimum clearance of 1/2" around restraining bolts and between the housings and the springs so as not to interfere with the spring action.
7. Limit stops shall be out of contact during normal operation.
8. Select isolators for equipment subjected to wind loads in conformance with ASCE 7-02.
9. Manufacturers:
    a. Mason "SLRS"
    b. Kinetics "FLS"
    c. Aeroflex "AWRS"
    d. Vibration Eliminator Co. "KW"

2.03 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.
4. Manufacturers:
    a. Mason "HD"
    b. Kinetics "RH"
    c. Aeroflex "RHD"
    d. Vibration Eliminator Co. "IC/3C/3CTD"
    e. Vibro Acoustics "RH"

B. Type H3:

1. Vibration hangers shall have a steel spring in a neoprene cup with a grommet to prevent short circuiting of the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Hangers shall be capable of holding the load at a fixed elevation during installation. They shall have a secondary adjustment to transfer the load to the spring and maintain the same position.
6. Deflection shall be indicated by a pointer and scale.
7. Manufacturer:
    a. Mason "30N"
    b. Kinetics "SFH"
    c. Amber/Booth "BSW"
    d. Vibration Eliminator Co. "SNRC"
    e. Vibro Acoustics "SHR"

2.04 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

A. Type FC1:

1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.
2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.
3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.
4. Connectors up to 2" size may have threaded ends.
5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.
6. All connectors shall be rated for a minimum working pressure of 150 psi at 200°F.
7. Manufacturer:
    a. Metraflex "Double Cable-Sphere"
    b. Minnesota Flex Corp.

c. Mercer "200 Series"
d. Twin City Hose "MS2".

B. Type FC2:
1. Stainless steel flexible connectors with corrugated stainless steel hose body and stainless steel braided casing.
2. Rated for minimum working pressures of 150 psi at 70°F and 100 psi at 800°F.
3. Sizes 2" and under shall have steel threaded connections.
4. Sizes 2-1/2" and over shall have 150 lb. steel flanges.
5. Suitable for 1/2" permanent misalignment.
6. Manufacturers:
a. Mason or Mercer "BSS-GU"
b. Metraflex "ML"
c. Twin City Hose "TCHS"
d. American "BOA B4-1"
e. Flexible Metal Hose Company "FM-21"
f. or Wheatley.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

3.02 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. Where piping is floor-supported, use M2 instead of H1.

C. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.

D. Use Type FC1 where pressures are lower than 150 psi, temperatures are below 220°F, and the fluid handled is compatible with neoprene and EPDM.

E. Use Type FC2 for all other services. FC2 shall be installed parallel with equipment shafts.

F. Provide sufficient piping flexibility for vibrating refrigerant equipment or furnish flexible connectors with appropriate temperature and pressure ratings.

G. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.

H. Support piping to prevent extension of flexible connectors.

3.03 VIBRATION ISOLATION OF DUCTWORK

A. The first three hangers on all fan systems shall be Type H1 with at least 0.20" minimum static deflection.

B. Provide flexible duct connections as described in Section 23 3300 at all fan inlets and outlets and on the mechanical room side of all locations where ducts penetrate mechanical room walls.

END OF SECTION

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VIBRATION ISOLATION SUBMITTAL FORM

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12
		PROPOSED ISOLATOR							CALCULATIONS		
ITEM SERVED	MIN DEFL (")	TAG	MODEL	MAX LOAD (#)	DEFL @ MAX LOAD (")	DEFL TO SOLID (")	FREE HT (")	Kx/Ky	LOAD (#)	DEFL (")	DEFL RATIO

COLUMN NOTES: Note numbers correspond to the column numbers above.

1. Item served should match designation on the design drawings.
2. List the deflection scheduled or specified in the design documents.
3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
4. List the manufacturer's complete model designation for the isolator.
5. List the manufacturer's maximum rated load for the isolator.
6. List the isolator deflection at the maximum rated load in column 5.
7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

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SECTION 23 0553
HVAC IDENTIFICATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Identification of products installed under Division 23.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. 3M

B. Bunting

C. Calpico

D. Craftmark

E. Emedco

F. Kolbi Industries

G. Seton

H. W. H. Brady

I. Marking Services.

2.02 MATERIALS

A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4" (32mm)	8" (200 mm)	1/2" (12 mm)
1-1/2" (40 mm) to 2" (50 mm)	8" (200 mm)	3/4" (20 mm)
2-1/2" (65 mm) to 6" (150 mm)	12" (300 mm)	1-1/4" (32 mm)
8" (200 mm) to 10" (250 mm)	24" (600 mm)	2-1/2" (65 mm)
Over 10" (250 mm)	32" (800 mm)	3-1/2" (90 mm)

Plastic tags may be used for outside diameters under 3/4" (20 mm)

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

H. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

I. Ceiling Markers:

1. Label Style:

a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves. An arrow can be used to point to the tile needing removal.

b. The label tape shall be approximately 1/2" wide with all capitalized letters approximately 3/16” tall.

c. Ceiling grid labels shall be made with a label maker with durable adhesive labels having a clear background and black letters.

d. Equipment labels shall be as designated on the drawings (e.g., FCU-606B, etc.).

e. Valve labels shall be designated by the size, service, and the valve tag number (e.g., 1-1/4” CW #123, 2” HWS #234, etc.). A single longer label can be used to identify multiple valves using spaces between the descriptors if the valves are located close together and have the same service (e.g., HWS and HWR valves serving the same equipment or CW, HW, and HWC lines serving the same restroom, etc.).

2. "Dot " Style:

a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves.

b. The marker shall be a self-adhesive color dot approximately 1/2” in diameter.

c. The equipment and accessories to be marked and dot color shall be coordinated with the Architect/Engineer and Owner.

1) Equipment and accessories to be marked:

a) Hydronic Valves

b) Project Specific Item

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.

2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.

3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.

4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.

5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.

6. Number all tags and show the service of the pipe.

7. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:
    a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
    b. Apply primer on non-insulated pipes before painting.
    c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
    a. At each valve.
    b. On both sides of walls that pipes penetrate.
    c. At least every 20 feet along all pipes.
    d. On each riser and each leg of each "T" joint.
    e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.02 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. HEATING WATER SUPPLY: White lettering; green background
2. HEATING WATER RETURN: White lettering; green background
3. CONDENSATE DRAIN: White lettering; green background
4. REFRIGERANT LIQUID: White lettering; purple background
5. REFRIGERANT SUCTION: White lettering; purple background
6. REFRIGERANT HOT GAS: White lettering; purple background

END OF SECTION

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Testing, adjusting, and balancing of air systems.

B. Testing, adjusting, and balancing of heating systems.

C. Testing, adjusting, and balancing of cooling systems.

D. Testing, adjusting, and balancing of plumbing systems.

E. Measurement of final operating condition of HVAC systems.

1.02 QUALITY ASSURANCE

A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section . Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.

B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.03 REFERENCES

A. AABC - National Standards for Total System Balance, Seventh Edition.

B. ADC - Test Code for Grilles, Registers, and Diffusers.

C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.

D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.

E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.

F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.

G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.

H. TABB - International Standards for Environmental Systems Balance.

1.04 SUBMITTALS

A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Electronic Copies:

1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.

3. All text shall be searchable.

4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

C. Paper Copies:

1. Submit four (4) certified copies of test reports to the Architect/Engineer for approval in soft cover, 3-hole binder manuals, with cover identification. Include index page and indexing tabs.

1.05 REPORT FORMS

A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.

B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.

C. Refer to PART 4 for required reports.

1.06 WARRANTY/GUARANTEE

A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.

B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.07 SCHEDULING

A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.

B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.

C. Recorded data shall represent actual measured or observed conditions.

D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.

E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.

G. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 23 0900 for additional information.

H. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.02 EXAMINATION

A. Before beginning work, verify that systems are complete and operable. Ensure the following:

1. General Equipment Requirements:
    a. Equipment is safe to operate and in normal condition.
    b. Equipment with moving parts is properly lubricated.
    c. Temperature control systems are complete and operable.

d. Proper thermal overload protection is in place for electrical equipment.
e. Direction of rotation of all fans and pumps is correct.
f. Access doors are closed and end caps are in place.

2. Duct System Requirements:
a. All filters are clean and in place. If required, install temporary media.
b. Duct systems are clean and free of debris.
c. Fire/smoke and manual volume dampers are in place, functional and open.
d. Air outlets are installed and connected.
e. Duct system leakage has been minimized.

3. Pipe System Requirements:
a. Coil fins have been cleaned and combed.
b. Hydronic systems have been cleaned, filled, and vented.
c. Strainer screens are clean and in place.
d. Shutoff, throttling and balancing valves are open.

B. Report any defects or deficiencies to Architect/Engineer.

C. Promptly report items that are abnormal or prevent proper balancing.

D. If, for design reasons, system cannot be properly balanced, report as soon as observed.

E. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.

B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.04 INSTALLATION TOLERANCES

A. ± 10% of scheduled values:
1. Adjust air inlets and outlets to ± 10% of scheduled values.
2. Adjust piping systems to ±10% of design values.

B. ± 5% of scheduled values:
1. Adjust kitchen exhaust systems to ± 5% of scheduled values.

C. + 5% of scheduled values
1. Adjust outdoor air intakes to within + 5% of scheduled values.

D. Adjust supply, return, and exhaust air-handling systems to +10% / -5% of scheduled values.

3.05 ADJUSTING

A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.

B. Once balancing of systems is complete, at least one damper or valve must be 100% open.

C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.

D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.

E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

3.06 SUBMISSION OF REPORTS

A. Fill in test results on appropriate forms.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.01 GENERAL REQUIREMENTS

A. Title Page:
   1. Project name.
   2. Project location.
   3. Project Architect.
   4. Project Engineer (IMEG Corp.).
   5. TAB Company name, address, phone number.
   6. TAB Supervisor's name and certification number.
   7. TAB Supervisor's signature and date.
   8. Report date.

B. Report Index

C. General Information:
   1. Test conditions.
   2. Nomenclature used throughout report.
   3. Notable system characteristics/discrepancies from design.
   4. Test standards followed.
   5. Any deficiencies noted.
   6. Quality assurance statement.

D. Instrument List:
   1. Instrument.
   2. Manufacturer, model, and serial number.
   3. Range.
   4. Calibration date.

4.02 AIR SYSTEMS

A. Duct Leakage Test - all ductwork upstream of VAV boxes connected to AHU-1:
   1. Air system and fan.
   2. Leakage class.
   3. Test pressure.
   4. Construction pressure.
   5. Flow rate (cfm): specified and actual.
   6. Leakage (refer to Section 23 3100 in the specifications): specified and actual.
   7. Statement that fire dampers, reheat coils and other accessories were included in the test.
   8. Pass or Fail.
   9. Test performed by.
   10. Test witnessed by.

B. Air Moving Equipment:
   1. General Requirements:
      a. Drawing symbol.
      b. Location.

c. Manufacturer, model, arrangement, class, discharge.
d. Fan RPM.
e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
f. Final frequency of motor at maximum flow rate (on fans driven by VFD).

2. Flow Rate:
a. Supply flow rate (cfm): specified and actual.
b. Return flow rate (cfm): specified and actual.
c. Outside flow rate (cfm): specified and actual.
d. Exhaust flow rate (cfm): specified and actual.

3. Pressure Drop and Pressure:
a. Filter pressure drop: specified and actual.
b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
c. Inlet pressure.
d. Discharge pressure.

C. Fan Data:
1. Drawing symbol.
2. Location.
3. Manufacturer and model.
4. Flow rate (cfm): specified and actual.
5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure.
7. Discharge pressure.
8. Fan RPM.

D. Electric Motors:
1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

E. Air Terminal (Inlet or Outlet):
1. Drawing symbol.
2. Room number/location.
3. Terminal type and size.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Percent of design flow rate.

F. Air Terminal Unit (Terminal Air Box) Data:
1. General Requirements:
a. Drawing symbol.
b. Location.
c. Manufacturer and model.
d. Size.
e. Type: constant, variable, single, dual duct.

2. Flow Rate:
    a. Cooling maximum flow rate (cfm): specified and actual.
    b. Heating maximum flow rate (cfm): specified and actual.
    c. Minimum flow rate (cfm): specified and actual.
3. Temperature:
    a. Entering air temperature: specified and actual.
    b. Leaving air temperature (in minimum airflow/heating mode): specified and actual.
4. Pressure Drop and Pressure:
    a. Inlet static pressure during testing cooling maximum airflow rate (maximum and minimum).
    b. Water pressure drop: specified and actual.

G. Air Flow Measuring Station:
1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

H. Kitchen Hoods:
1. Drawing symbol.
2. Location.
3. Manufacturer and Model.
4. Total flow rate (cfm): specified and actual.
5. Test velocities.
6. Hood opening dimensions.

4.03 HEATING SYSTEMS

A. Heating Coils:
1. General Requirements:
    a. Drawing symbol.
    b. Service.
    c. Location.
    d. Manufacturer and model.
    e. Size.
2. Flow Rate:
    a. Flow rate (cfm): specified and actual.
3. Temperature:
    a. Entering air temperature: specified and actual.
    b. Leaving air temperature: specified and actual.
4. Pressure Drop and Pressure:
    a. Air pressure drop: specified and actual.
5. Energy:
    a. Air Btuh (cfm x temp rise x 1.09).

4.04 COOLING SYSTEMS

A. Cooling Coils:

1. General Requirements:
    a. Drawing symbol.
    b. Service.
    c. Location.
    d. Size.
    e. Manufacturer and model.
2. Temperature:
    a. Entering air DB temperature: specified and actual.
    b. Entering air WB temperature: specified and actual.
    c. Leaving air DB temperature: specified and actual.
    d. Leaving air WB temperature: specified and actual.
3. Flow Rate:
    a. Flow rate (cfm): specified and actual.
4. Pressure Drop and Pressure:
    a. Air pressure drop: specified and actual.
5. Energy:
    a. Air Btuh (cfm x enthalpy change x 4.5).

4.05 PLUMBING SYSTEMS

A. Pump Data:

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, model, frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

D. Gas Fired Water Heater:
   1. Drawing symbol.
   2. Service.
   3. Location.
   4. Manufacturer and model.
   5. Capacity (Btuh): specified, nameplate, and actual.
   6. Entering water temperature: specified and actual.
   7. Leaving water temperature: specified and actual.
   8. Pressure Drop: specified and actual.
   9. Control Setting: specified and actual.

END OF SECTION

SECTION 23 0713
DUCTWORK INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Ductwork Insulation.

B. Insulation Jackets.

1.02 QUALITY ASSURANCE

A. Materials:

1. Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.

B. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include product description, list of materials and thickness for each service, and location.

B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.

B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum 'K' value at 75°F; foil scrim Kraft facing, 3 lb./cu. ft. density.

C. Type F: Flexible High Temperature Wrap; ASTM E2336 rating as 2-hour separation with zero clearance to combustible materials over the full length. Material to be totally scrim encapsulated. Material to be a minimum 1-1/2" thick with a minimum core density of 6 pcf. Wrap system should offer zero clearance to combustibles per ASTM E2336 at all locations, comply with all applicable codes, and be approved by AHJ. If system is not rated for zero clearance per ASTM E2336 at all locations with single layer, a two-layer system shall be provided with zero clearance per ASTM E2336 at all locations. Material must be tested and listed for installation on grease ducts and installed per listed design. Refer to Section 23 3300 for prefabricated, pre-insulated access doors required for grease duct systems.

2.02 JACKETS

A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.

B. Install materials after ductwork has been tested.

C. Clean surfaces for adhesives.

D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.

E. Exterior Duct Wrap - Flexible, Type A:

1. Apply with edges tightly butted.
2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
3. Seal joints with adhesive backed tape.
4. Apply so insulation conforms uniformly and firmly to duct.
5. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
6. Provide high-density insulation inserts on rectangular ducts at trapeze duct hangers to prevent crushing of insulation. Provide high-density insulation inserts with clamp-on round ducts requiring two (2) rods or straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
9. Staples may be used, but must be covered with tape.
10. Vapor barrier must be continuous.
11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

F. Semi Rigid Fiberglass Board Wrap - Type B (Indoor Use):

1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
2. Space pins as needed to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.
4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.

G. Exterior Fire Protection, Flexible Type - Type F:

1. Cut and secure duct wrap around ductwork, support angles, and hangers per manufacturer's recommendations.
2. Seal all joints as required to maintain enclosure rating.
3. Installation shall be rated for 2 hours, unless otherwise noted.
4. Provide manufacturer's recommended assembly to protect all access doors to maintain enclosure rating and to permit easy replacement of insulation.

H. Continue insulation with vapor barrier through penetrations unless code prohibits.

I. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

3.02 SCHEDULE

A. Refer to Section 23 3100 for scheduling of insulation.

END OF SECTION

SECTION 23 0719
HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping Insulation.

B. Insulation Jackets.

1.02 QUALITY ASSURANCE

A. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.01 INSULATION

A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.29 maximum 'K' value at 75°F; density 7.3lb/ft; minimum compressive strength 90 psi parallel to rise; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose polymer or polypropylene service jacket for above grade installations.

D. Type D: Hydrous Calcium Silicate; ASTM C533; rigid molded pipe insulation; asbestos free; 0.40 'K' value at 300°F; 1200°F maximum service temperature; 16 gauge stainless steel tie wires on maximum 12" centers.

E. Type E: Preformed rigid cellular polyisocyanurate insulation; ANSI/ASTM C591; maximum 'K' value of 0.19 at 75°F; density 4.0lb/ft; minimum compressive strength 95 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -297°F to +300°F.

F. Type F: Phenolic insulation; ASTM C1126; maximum 'K' value of 0.22 at 75°F; density 3.75lb/ft; minimum compressive strength 50 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -290°F to +250°F.

2.02 VAPOR BARRIER JACKETS

A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

2.03 JACKET COVERINGS

A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use.

B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

B. Patch and repair torn insulation. Paint to match adjacent insulation surface.

3.02 INSTALLATION

A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
3. All piping and insulation that does not meet 25/50 that is in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has been listed and labeled having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested as a composite in accordance with ASTM E84 or UL 723.
4. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall studs, and the insulation shall butt up to each stud.

B. Insulated Piping Operating Below 60°F:

1. Insulate fittings, valves, unions, flanges, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves and strainers with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow access for reading and adjusting of the balancing valve and cleaning and servicing of the balancing valve.

C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140°F:

1. Insulate fittings, valves, flanges, float & thermostatic steam traps, and strainers. On gate valves, the insulation shall be extended to cover the entire valve bonnet, leaving only the portion of the stem that is above the bonnet and valve operator exposed.
2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
3. The use of removable insulation jackets is acceptable for insulating large and non-cylindrical shaped piping components (e.g., check valves, pressure regulating valves, calibrated balance valves, gate valve bonnets, F&T traps, strainers, line sets, and the like).

E. Refrigerant Piping:

1. On refrigerant piping (25°F and above) and not required to meet the 25/50 flame/smoke, provide at each strut or clevis support an insulation coupling to support pipe and to accept insulation thickness of adjoining insulation, to prevent insulation from sagging and crushing. The coupling shall be suitable for planned temperatures, use with specified pipe material, and shall be a 360°, one-piece cylindrical segment. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Contractor shall apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.

F. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

3.03 SUPPORT PROTECTION

A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.

B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
    a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    b. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" to 10". For pipe sizes larger than 10", provide rolled steel plate in addition to the shield. Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall be listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
    c. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14, provide rolled steel plate in addition to the shield.
    d. Phenolic (for pipes operating below 250°F with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    e. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
        1) Products:
            a) Buckaroo CoolDry
            b) Cooper/B-Line Fig. B3380 through B3384
            c) Pipe Shields A1000, A2000
    f. Insulation Couplings:
        1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.

2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
   a) Klo-Shure or equal
3) Vertical Manufacturers:
   a) Manufacturers: Klo-Shure Titan or equal

g. Rectangular blocks, plugs, or wood material are not acceptable.

h. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5” to 6"	18" long x 16 gauge
8” to 14"	24" long x 14 gauge
16” to 24"	24" long x 12 gauge

F. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 23 0529 "HVAC Supports and Anchors".

G. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

3.04 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.
4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer’s instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.

3. Insulation Installation on Straight Pipes and Tubes:
    a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
    b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
    a. Install preformed sections of same material as straight segments of pipe insulation when available.
    b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
    c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type C Insulation:
1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
2. Insulate fittings with prefabricated fittings.

D. Type D Insulation:
1. Use pre-molded half sections. Butt longitudinal and circumferential joints tightly. Wire in place with 16 gauge stainless steel wire on maximum 12" centers.
2. Apply in two layers. Stagger all joints between layers. Wire each layer individually.

E. Type E Insulation:
1. Indoors, above grade or below grade, Polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
2. Insulate pipe fittings with prefabricated insulation fittings.

F. Type F Insulation:
1. Seal all longitudinal joints with manufacturer approved adhesive or mastic. Secure butt joint strips in a similar manner.
2. Indoors, above grade or below grade, polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
3. Insulate pipe fittings with prefabricated insulation fittings.

3.05 JACKET COVER INSTALLATION

A. Metal Covering:
1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.
2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.
3. Interior joints do not need to be sealed.
4. Use metal covering on the following pipes:
    a. All exterior piping.

B. Plastic Covering:
1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.

3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. All joints in areas noted shall meet USDA standards for Totally Sealed Systems, including overlaps of 1" on circumferential and 1.5" to 2" on longitudinal seams.
5. Use plastic insulation covering on all exposed pipes including, but not limited to:
    a. All exposed piping in finished spaces.
    b. All exposed piping below 8'-0" above floor.
    c. All piping in mechanical rooms and/or tunnels that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
    d. All kitchen areas.

3.06 SCHEDULE

A. Refer to drawings for insulation schedule.

END OF SECTION

SECTION 23 0800
HVAC COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Provider (CxP) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Control system.
   2. Major and minor equipment items.
   3. Piping systems and equipment.
   4. Ductwork and accessories.
   5. Terminal units.
   6. Variable frequency drives.
   7. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.

B. Section 017900 - Demonstration and Training: Scope and procedures for Owner personnel training.

C. Section 019113 – General Commissioning Requirements

1.03 REFERENCE STANDARDS

A. ASHRAE Guideline 0-2013 – The Commissioning Process.

B. ASHRAE Standard 202-2018 - Commissioning Process for Buildings and Systems.

1.04 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Provider informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
   1. System name.
   2. List of devices.
   3. Step-by-step procedures for testing each controller after installation, including:
      a. Process of verifying proper hardware and wiring installation.
      b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
      c. Process of performing operational checks of each controlled component.

d. Plan and process for calibrating valve and damper actuators and all sensors.
e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.
5. Description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Provider and TAB contractor for this determination.

C. Startup Reports and Trend Logs: Submit for approval of Commissioning Provider.

D. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
1. Full as-built set of control drawings.
2. Full as-built sequence of operations for each piece of equipment.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

C. The building automation system (BAS) contractor shall provide a temporary username and password login to the BAS for the CxP, which can be read only.

PART 3 EXECUTION

3.01 GENERAL

A. Cloud based software will be utilized for maintaining Prefunctional Checklists, Functional Performance Testing and Issue management. Contractors will be required to utilize the system. Logins will be provided to the contractors, and the software does not require a subscription fee from the contractors.

3.02 PREPARATION

A. Cooperate with the Commissioning Provider in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Provider.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Provider; update the schedule as appropriate.

D. Notify the Commissioning Provider when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Provider has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing, close with an approved plug.

G. Provide temperature and pressure taps in accordance with Contract Documents.

3.03 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Provider for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If the actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

E. Isolation Valve or System Valve Leak Check: For valves not by coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.04 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. Provide all necessary unique instruments and instruct the TAB technicians in their use, such as handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Provider prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.05 FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.

C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Provider.

D. The Contractor is responsible to ensure that equipment is ready for functional testing with the CxP which means the equipment will pass the measures in the test procedures previously submitted for their review and use. The responsible subcontractors use these written test procedures to checkout their equipment and shall dynamically run (not by simulation) the

equipment through the test procedures prior to testing with the CxP, unless exempted elsewhere in the specifications. The installing and automated controls contractors shall sign the test procedure attesting to this successful pre-test execution and final test readiness prior to functional testing with the CxP.

E. Prior to testing with the CxP, trending and archiving must have been set up by the BAS Controls contractor and is active for all points that are relevant for verifying proper operation or for troubleshooting

F. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

G. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

H. Demonstrate the following to the Commissioning Provider during testing of controlled equipment, coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

I. Demonstrate to the Commissioning Provider:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.
   5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent, if any of those fail test all remaining units at no extra cost to Owner.
   6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
   7. Power failure and battery backup and power-up restart functions.
   8. Global commands features.
   9. Security and access codes.
   10. Occupant over-rides (manual, telephone, key, keypad, etc.).
   11. O&M schedules and alarms.
   12. Occupancy sensors and controls.
   13. Communications to remote sites.
   14. Fire alarm interlocks and response.
   15. Fire protection and suppression systems interfaces.
   16. That points that are monitored only, having no control function, are reporting properly to the control system.
   17. All control strategies and sequences not tested during controlled equipment testing.
   18. Trend logging and graphing features that are specified.
   19. Other integrated tests specified in Contract Documents
   20. That control system features that are included but not specified to be setup are actually installed.

J. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 01 7900 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Provider during Functional Testing.

D. Provide hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned.

E. Provide the services of manufacturer representatives to assist instructors where necessary.

F. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

SECTION 23 0900
CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Complete System of Automatic Controls.

B. Control Devices, Components, Wiring and Material.

C. Instructions for Owners.

D. Remodeling.

1.02 QUALITY ASSURANCE

A. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

1.03 SUBMITTALS

A. Equipment Coordination:

1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
2. Control valve selections shall be based on flow rates shown in approved shop drawings.
3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

B. Shop Drawings:

1. Submit shop drawings per Section 23 0500. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:
    a. Wiring diagrams and layouts for each control panel showing all termination numbers.
    b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
    c. Identification of all control components connected to emergency power.
    d. Schematic diagrams for all field sensors and controllers.
    e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
    f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
    g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.

h. All installation details and any other details required to demonstrate that the system will function properly.

i. All interface requirements with other systems.

6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.

8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.

9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:

   a. Damper Identification Tag.

   b. Location.

   c. Damper Type.

   d. Damper Size.

   e. Duct Size.

   f. Arrangement.

   g. Blade Type.

   h. Velocity.

   i. Pressure Drop.

   j. Fail Position.

   k. Actuator Identification Tag.

   l. Actuator Type.

   m. Mounting.

10. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:

    a. Valve Identification Tag.

    b. Location.

    c. Valve Type.

    d. Valve Size.

    e. Pipe Size.

    f. Configuration.

    g. Flow Characteristics.

h. Capacity.

i. Valve C_V.

j. Design Pressure Drop.

k. Pressure Drop at Design Flow.

l. Fail Position.

m. Close-off Pressure.

n. Valve and Actuator Model Number and Type.

11. Indoor modular air handling units (Section 23 7313) and mixed flow return air fans (Section 23 3413) provided under this project will have piezometer type sensors mounted at fan inlets by fan manufacturer. Fan manufacturer will provide fan specific flow coefficients and equations that can be used to calculate fan airflow based on measured pressure differential at fan inlet. TCC shall provide the following:

    a. Quantity of pressure transducers so that each individual fan is served by a dedicated pressure transducer. Each pressure transducer shall have a range that is selected based on scheduled maximum airflow for each fan. TCC shall submit a schedule that shows the following calculations for each fan/pressure transducer:

        1) Pressure drop at maximum scheduled airflow for each fan using fan manufacturer's flow coefficient.

        2) Recommended transducer range.

    b. Pneumatic tubing as required to interconnect all piezometer type sensors and pressure transducer.

    c. Fasteners and supports as required to securely attached tubing, pressure transducers, conduits, wiring, and the like for a complete installation.

12. Airflow Measuring Station Schedule:

    a. The manufacturer's authorized representative shall prepare the airflow measuring station submittal, or review and approve in writing the submittal prepared by the TCC prior to submission to the Architect/Engineer and prior to installation. The representative shall review air handling equipment submittals and duct fabrication drawings to ensure that all AFMS locations meet the appropriate parameters to achieve proper installation and the specified accuracy. Comply with all manufacturer's installation requirements including straight up and downstream duct lengths. Install airflow straighteners if required by the manufacturer based on installation constraints. The Architect/Engineer shall be notified for approval of any deviations.

    b. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.

    c. Submit installation, operation, and maintenance documentation.

13. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

14. Provide PICS files indicating the BACnet functionality and configuration of each device.

15. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version

that meets BTL testing and listing requirements if problems are found during BTL testing is required.

16. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.
17. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
18. Clearly identify work by others in the submittal.
19. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 23 0500, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:
    a. Table of contents with indexed tabs dividing information as outlined below.
    b. Definitions: List of all abbreviations and technical terms with definitions.
    c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
    d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
    e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
    f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
    g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
    h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
    i. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
    j. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.

D. Training Manual:

1. Provide a course outline and training manuals for each training class.

E. Record Documents:

1. Submit record documentation per Section 23 0500.
2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall

also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.

3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.

1.04 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.05 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Control Valves.

B. Temperature Sensor Sockets.

C. Gauge Taps.

D. Automatic Dampers.

1.06 AGENCY AND CODE APPROVALS

A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.

1. UL-916; Energy Management Systems.
2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
3. EMC Directive 89/336/EEC (European CE Mark).
4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.07 ACRONYMS

A. Acronyms used in this specification are as follows:

1. B-AAC BACnet Advanced Application Controller
2. B-ASC BACnet Application Specific Controller
3. BTL BACnet Testing Laboratories
4. DDC Direct Digital Controls
5. FMCS Facility Management and Control System
6. GUI Graphic User Interface
7. IBC Interoperable BACnet Controller
8. IDC Interoperable Digital Controller
9. LAN Local Area Network
10. NAC Network Area Controller
11. ODBC Open DataBase Connectivity
12. OOT Object Oriented Technology
13. OPC Open Connectivity via Open Standards
14. PICS Product Interoperability Compliance Statement
15. PMI Power Measurement Interface

16. POT Portable Operator's Terminal
17. TCC Temperature Control Contractor
18. TCS Temperature Control System
19. WAN Wide Area Network
20. WBI Web Browser Interface

1.08 SUMMARY

A. Extend Existing System:

1. Extend the existing FMCS for this project. The existing facility has a Johnson Controls system with the head end computer located in the MHI building and another workstation in the CCF building. There is an existing BACnet engine that has space capacity for a BACnet trunk located in the CCF building at the south west corner maintenance office as noted on sheet M1.3. Jim Peavler with Johnson Controls out of Omaha has additional information on the existing system. His contact number is 402-891-5843.

B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.

C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.

D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

1.09 SYSTEM DESCRIPTION

A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.

B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.

C. Provide materials and labor necessary to connect factory supplied control components.

D. Provide central and remote hardware, software, and interconnecting wire and conduit.

E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.

F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.

G. For each operator workstation provided, furnish one legal copy of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be readily available in the market. Contractor shall convey to the Owner all software tools and their legal licenses at project closeout.

1.10 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

1.11 WARRANTY

A. Refer to Section 23 0500 for warranty requirements.

B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.

C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.

D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

1.12 WARRANTY ACCESS

A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. BACnet Protocol:

1. Johnson Controls: Metasys Extended Architecture

2.02 SYSTEM ARCHITECTURE

A. General:

1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.

2. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

B. Open, Interoperable, Integrated Architectures:

1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.

2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs are not acceptable.

3. Hierarchical or "flat" topologies are required to have system response times as indicated below and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network.

a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.

b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.03 NETWORKS

A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE Standard 802.3.
2. Cable; 100 Base-T, UTP-8 wire, Category 6.
3. Minimum throughput; 100 Mbps.

C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.

D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.

E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

2.04 NETWORK AREA CONTROLLER (NAC)

A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.

B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:

1. Calendar functions.
2. Scheduling.
3. Trending.
4. Alarm monitoring and routing.
5. Time synchronization.
6. Integration of all controller data.
7. Network Management functions.

C. The Network Area Controller shall provide the following hardware features as a minimum:

1. One Ethernet Port - 10/100 Mbps.
2. One RS-232 port.
3. One LonWorks Interface Port - 78KB FTT-10A (for LonWorks systems only).
4. One RS-485 port.
5. Battery backup.
6. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
7. The NAC must be capable of operation over a temperature range of 32°F to 122°F.
8. The NAC must be capable of withstanding storage temperatures of between 0°F and 158°F.
9. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.

D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the NAC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.

F. Event Alarm Notification and Actions:

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
    a. Alarm
    b. Normal
4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g., security, HVAC, Fire, etc.
5. Provide timed (scheduled) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Treat control equipment and network failures as alarms and annunciated.

H. Annunciate alarms in any of the following manners as defined by the user:

1. Screen message text.
2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
    a. Day of week.
    b. Time of day.
    c. Recipient.
3. Pagers via paging services that initiate a page on receipt of e-mail message.
4. Graphic with flashing alarm object(s).
5. Printed message, routed directly to a dedicated alarm printer.

I. The FMCS shall record the following for each alarm:

1. Time and date.
2. Location (building, floor, zone, office number, etc.).
3. Equipment tag.
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

J. Give defined users proper access to acknowledge any alarm.

K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

L. Provide a "query" feature to allow review of specific alarms by user-defined parameters.

M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

2.05 BACNET FMCS

A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).

C. Interoperable BACnet Controller (IBC):

1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system's compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
    a. BACnet Building Controller(s) (B-BC).
    b. BACnet Advanced Application Controller(s) (B-ACC).
    c. BACnet Application Specific Controller(s) (B-ASC).
3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.
6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
    a. BACnet Device; MAC address, name, type and instance number.
    b. BACnet Objects; name, type and instance number.
7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.

D. Object Libraries:

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.

4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
    a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.
    b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
    c. Override Object: Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
    d. Start-Stop Time Optimization Object: Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.
    e. Demand Limiting Object: Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.
6. The library shall include control objects for the following functions:
    a. Analog Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
    b. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.
    c. Binary Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
    d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.

e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.

f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.

i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.

j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.

k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.

7. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). Provide the following as part of the standard library included with the programming software:

a. LonMark/LonWorks Devices: These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. Support all network variables defined in the LonMark profile. The device manufacturer shall provide information (type and function) regarding network variables not defined in the LonMark profile.

b. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file, and documentation for the device to facilitate device integration.

c. For BACnet devices, provide the following objects:

1) Analog In.

2) Analog Out.

3) Analog Value.

4) Binary.
5) Binary In.
6) Binary Out.
7) Binary Value.
8) Multi-State In.
9) Multi-State Out.
10) Multi-State Value.
11) Schedule Export.
12) Calendar Export.
13) Trend Export.
14) Device.

d. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

e. For BACnet devices, provide the following support at a minimum:
1) Segmentation.
2) Segmented Request.
3) Segmented Response.
4) Application Services.
5) Read Property.
6) Read Property Multiple.
7) Write Property.
8) Write Property Multiple.
9) Confirmed Event Notification.
10) Unconfirmed Event Notification.
11) Acknowledge Alarm.
12) Get Alarm Summary.
13) Who-has.
14) I-have.
15) Who-is.
16) I-am.
17) Subscribe COV.
18) Confirmed COV notification.
19) Unconfirmed COV notification.
20) Media Types.
21) Ethernet.
22) BACnet IP Annex J.
23) MSTP.
24) BACnet Broadcast Management Device (BBMD) function.
25) Routing.

2.06 TERMINAL AIR BOX (TAB) CONTROLLERS

A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 23 3600 for additional information.

B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.

C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.

D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.

E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.

F. BACnet TAB controllers shall either be B-AAC devices or B-ASC devices as required to meet the performance and BTL listing.

2.07 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

A. The NAC shall be able to collect data for any property of any object and store resident in the NAC that shall have, at a minimum, the following configurable properties:

1. Designating the log as interval or deviation.
2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

B. Store all log data in a relational database in the NAC that is accessible from a server (if the system is so configured) or a standard Web browser.

C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

D. All log data shall be available to the user in ALL the following data formats:

1. HTML.
2. XML.
3. Plain text.
4. Comma or tab separated values.

E. The NAC shall archive its log data either locally (to itself) or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties:

1. Archive on time of day.
2. Archive on user-defined number of data stores in the log (buffer size).
3. Archive when log has reached its user-defined capacity of data stores.
4. Provide ability to clear logs once archived.

2.08 AUDIT LOG

A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:

1. Time and date.
2. User ID.
3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

2.09 DATABASE BACKUP AND STORAGE

A. The NAC shall automatically backup its database on a user-defined time interval.

B. Store copies of the current database and, at the most, the recently saved database in the NAC. The age of the most recently saved database shall depend on the user-defined database save interval.

C. Store the NAC database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

2.10 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. A UPS shall be provided for each of the following:

1. Network area controllers.

B. Provide a 120-volt 60 Hz line-interactive uninterruptible power supply with backup battery capacity for 5 minutes at 100% load. UPS shall have hot swappable batteries, automatic battery self-test and start-on-battery capabilities. Batteries shall be valve regulated, sealed lead acid type. UPS shall have sine wave shape output waveform. UPS shall be UL 1778 list and comply with FCC Part 15, Class A.

C. Manufacturers:

1. Sola/Hevi-Duty
2. Eaton Powerware
3. APC

2.11 SYSTEM PROGRAMMING

A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.

B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.

C. Programming Methods:

1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.
2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.12 DDE DEVICE INTEGRATION

A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The NAC shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:

1. DDE Generic AI Object.
2. DDE Generic AO Object.
3. DDE Generic BO Object.
4. DDE Generic BI Object.

2.13 MODBUS SYSTEM INTEGRATION

A. The NAC shall support integration of device data from Modbus RTU, ASCII, and TCP control system devices. Connect to the Modbus system via an RS-232, RS485, or Ethernet IP as required by the device.

B. Provide the required objects in the library included with the GUI programming software to support the integration of the Modbus system data into the FMCS. Objects provided shall include, at a minimum:

1. Read/Write Modbus AI Registers.
2. Read/Write Modbus AO Registers.
3. Read/Write Modbus BI Registers.
4. Read/Write Modbus BO Registers.

C. The NAC shall perform all scheduling, alarming, logging and global supervisory control functions of the Modbus system devices.

D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment using Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning.

2.14 CONTROL DAMPERS

A. Rectangular Control Dampers - Standard Construction:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid stainless steel with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.

6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
11. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24" x 24" damper (2000 fpm).
13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24" x 24" damper (2000 fpm).

B. Thermally Insulated Control Damper:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Extruded aluminum, minimum 4" deep, 0.080" minimum thickness.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, internally insulated with expanded polyurethane foam and thermally broken, with overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid stainless steel shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
8. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
9. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
10. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
11. Maximum Pressure Drop: 0.21" for 8,000 cfm through a 24" x 24" damper (2000 fpm).

2.15 DAMPER ACTUATORS

A. Damper Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Dampers: Where shown on the drawings or sequences, fail-safe mechanism shall operate the damper to the fail position following power interruption.
    a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.
    b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10 percent increments with a 10 second operational delay.
5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.
6. Damper End Switches: Where shown on the drawings or sequences, provide end switches to prove damper reaches open/closed position.

2.16 CONTROL INSTRUMENTATION

A. Temperature Measuring Devices:

1. Electric Thermostats:
    a. Single Temperature - Line Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, concealed temperature adjustment, locking cover, rated for load, single or double pole as required.
    b. Single Temperature - Low Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, anticipator circuits, concealed temperature adjustment, locking cover, 24 V control transformer (if not included with unit under control), single or double pole as required.
2. Low Limit Switch:
    a. Provide one foot of sensing element for each one square foot of coil area, maximum element length 25 feet, of the vapor tension type, so that any point along the entire length of measuring element can trigger the switch.
    b. Provide 3" minimum radius capillary support clips at each turn.
    c. Furnish each thermostat with one single pole, single throw normally-opened switch and one single pole, single throw normally-closed auxiliary switch.
    d. Setpoint range shall be 15°F to 55°F with a permanent stop at 35°F.
    e. Differential shall be fixed at approximately 5°F and supplied with manual reset.

B. Temperature Sensors:

1. Room Temperature Sensor:
    a. Sensor Only: Stainless steel face plate sensor with flush mounting and tamper proof installation and screws, hermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, ± 0.50°F accuracy, no setpoint adjustment or override button.
2. Duct Temperature Sensor:

a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.

3. Water Temperature Sensor:

a. Install in immersion wells. Separate thermometers as specified elsewhere, also of the immersion well type, shall be installed within 2 feet of each temperature sensor.

C. Humidity Measuring Devices:

1. Humidity Sensors:

a. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be minimum of 2.0 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH humidity at temperatures from 50°F to 104°F.

2. Humidistats:

a. Room Humidistats: Wall-mounted, proportioning type, with adjustable 2% RH throttling range, operating range from 30% to 80% at temperatures up to 110°F, cover with concealed setpoint. Accuracy shall be minimum of 1.5 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH at temperatures from 50°F to 104°F.

D. Enthalpy Sensors: Duct-mounted enthalpy sensor shall include solid state temperature and humidity sensors with electronics that shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

E. Pressure Measuring Devices

1. Differential Pressure Switches:

a. Standard Pressure Switches:

1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.

2) Accuracy shall be ± 3% of full scale maximum throughout entire range at 70°F.

3) Provide mounting brackets, probes, and shutoff valves required for proper installation.

4) The range and service shall be as required for application or as noted on the drawings.

5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.

6) Provide latching relays that require manual reset once activated.

7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.

b. High Pressure Switches (Manual Reset):

1) Differential pressure switch with single pole, double-throw snap switch and enclosure.

2) Rated for pressure specified in sequence of control.

3) Electrical rating shall be 15 amps at 120-480 volts.

4) Setpoint adjustment shall be screw type located inside enclosure.

5) Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.

6) Repeatability: ±± 3%.

2. Pressure Transmitters/Transducer:

a. Air-to-Air:

1) Provide transducer having the following minimum performance for measuring duct static pressure for VFD control or measuring differential pressure across filter banks:

a) Accuracy: ±1.0% FS

b) Non-Linearity, BFSL: ±0.96% FS

c) Hysteresis: 0.10% full scale

d) Non-Repeatability: 0.05% full scale

e) Thermal Effects (compensated range): 0°F to +150°F

f) Maximum Line Pressure: 10 PSI

g) Zero/Span Shift: 0.033%FS/°F

h) Long Term Stability: 0.5%FS/1year

2) Provide transducer with the following minimum performance for measuring differential pressure across piezometer fan inlet airflow measuring stations:

a) Unit shall come factory equipped with static tube attached.

b) Unit shall include: (1) LCD shall display differential pressure on face of sensor enclosure over the entire operational range, and (2) IPCC-rated polycarbonate enclosure with short circuit proof outputs and reverse polarity protected inputs.

c) Accuracy at 72°F: ±0.25% FS

d) Stability: ±0.25% full scale per year

e) Temperature Error: (1) Zero: ±0.025% full scale per °C, (2) Span: Maximum ±0.03% full scale per °C

f) Environmental Operating Range: 32°F to 140°F.

g) Overpressure: Proof: (1) 2 psi, (2) Burst: 3 psi

h) Humidity: 0% to 95% RH non-condensing.

F. Flow Measuring Devices:

1. Airflow Measuring Stations:

a. Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion:

1) Provide airflow/temperature measurement devices where indicated on the plans.

2) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

a) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

b) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.

c) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.

d) Devices using less than two thermistors in each sensor assembly are not acceptable.

e) Devices using platinum wire RTDs are not acceptable.

f) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.

g) Pitot tubes and arrays are not acceptable.

h) Vortex shedding devices are not acceptable.

3) All Sensor Probes:

a) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.

b) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).

c) Airflow measuring station assembly accuracy shall be ± 2% of Reading over the entire operating airflow range. Temperature accuracy shall be ± 0.15° F between -20° F and 160° F.

d) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).

e) Each sensor probe shall have an integral, UL listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

f) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.

4) Duct and Plenum Probes:

a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.

b) Probe assembly mounting brackets shall be constructed of 304 stainless steel.

c) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5) Sensor Density:

Area (sq. ft.)	**Total # of Sensors Required**
Less than 2	4
2 to less than 4	6
4 to less than 8	8
8 to less than 16	12
≥ 16	16

6) Transmitters:

a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.

b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.

c) The operating temperature range for the transmitter shall be -20° F to 120° F.

d) The transmitter shall be capable of communicating with other devices using one of the following interface options:

e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)

f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.

h) Option 4: LonWorks Free Topology

b. Fan Inlet Airflow Measuring Stations (AFMS) - Thermal Dispersion:
   1) Sensor assemblies shall be mounted on 304 stainless steel housings.
   2) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
   3) Mounting feet shall be constructed of 304 stainless steel and securely riveted in place to prevent loosening over time due to vibration.
   4) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
   5) Transmitters
      a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
      b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
      c) The operating temperature range for the transmitter shall be -20° F to 120° F.
      d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
      e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
      f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
      g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
      h) Option 4: LonWorks Free Topology
   6) The AFMS shall be UL listed as an entire assembly.

c. Fan Inlet Airflow Measuring Stations - Differential Pressure:
   1) Fan Inlet Measuring Station Pressure Sensors, Transmitters and Transducers:
      a) Select for appropriate pressure range, fan type, inlet velocity, and airflow volume.
      b) Transmitter features and minimum performance requirements shall be as follows: (1) Combined Accuracy: ± 0.50%, (2) Terminal Point Nonlinearity: ± 0.40%, (3) Hysteresis: ± 0.02%., (4) Non-repeatability: ± 0.05%, (5) Compensation Range - Zero Shift: ±0.025% FS/°F, Span Shift: 0.025% FS/°F, (6) Differential Overpressure: 5 psi proof and 25 psi burst pressure, (7) Output signal: 0 to 10 VDC.
      c) Each transducer shall be provided with an integral manual zeroing valve to allow for field calibration of the zero-reference value without the need for shutting the operating system down.
      d) System airflow (measured in CFM) shall be continuously displayed on an LCD display meter (0.5 inches high by 3.5 digits) located on the face of the air volume/velocity transducer control enclosure.

d. Mounting of fan inlet static pressure sensing elements shall be in accordance with manufacturer's published installation instructions to ensure accuracy of readings.

G. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:

a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:

a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

H. Miscellaneous Devices:

1. Application Specific Controller Power Supply:

a. For use with terminal air box.

b. Provide multiple enclosures with the following accessories and components as required to provide 24VAC power to terminal air boxes, differential pressure monitors, damper actuators, valve actuators, and other components and devices as required.

c. NEMA-1 steel enclosures (12"x12"x6") with separate high and low voltage compartments and separate access covers.

d. Either one 300 VA power supply with three 100 VA Class 2 outputs, or one 500 VA power supply with five 100 VA Class 2 outputs.

e. Primary side shall receive 480/277/240/120 input to 24 VAC ungrounded, isolated output on the secondary side.

f. Each secondary output shall include a 4 amp breaker, on/off switch, and LED indicator. Terminal blocks shall accept 16-22 AWG wire.

g. Acceptable Manufacturer:

1) RIB Functional Devices Model MSH300A-LVC or PSH500A-LVC

2. Control Relays:

a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.

b. Mount all relays and power supplies in a NEMA 12 enclosure beside the FMCS panel or controlled device and clearly label their functions.

I. Outdoor Weather Station:

1. Outdoor rated ventilated plastic enclosure, off-white color, radiation shield including the following parameters.

2. Measured Parameters:

a. Temperature Sensor: Thermistor sensing element or resistance temperature device (RTD).

1) Operating Range: -40°F to 140°F

2) Accuracy: ± 0.54°F at 68°F

b. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service.
   1) Measurement Range: 0-100% RH
   2) Accuracy:
      a) ± 3% of reading from 0%-90% RH at 50°F to 86°F
      b) ± 5% of reading from 0%-90% RH at -4°F to 50°F and 86°F to 140°F.

3. Calculated Parameters:
   a. Dew Point Temperature in °F
   b. Wet Bulb Temperature in °F
   c. Enthalpy. Enthalpy sensor shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

2.17 CONDUIT AND BOXES

A. Conduit and Boxes: Refer to Electrical Section 26 0533 for materials, sizing, and other requirements

B. Conduit and Box Identification (Color and Labeling):
   1. Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for raceway and box color requirements.
   2. Refer to Electrical Section 26 0553 for raceway and box labeling requirements.

2.18 WIRE AND CABLE

A. Wire and Cable: Refer to Electrical Section 26 0513 for wire and cable materials.
   1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for wire and cable color requirements.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.

B. Install system and materials in accordance with manufacturer's instructions.

C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.

D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.

E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed ADA mounting requirements.

F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.

G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.

H. After completion of installation, test and adjust control equipment.

I. Check calibration of instruments. Recalibrate or replace.

J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.

K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall be powered from the optional standby branch of emergency power. In no instance shall panel be connected to the life safety or critical branch of the emergency power system. Panels may be connected to a common 20 amp, 120 volt circuit provided the total load on the circuit does not exceed 16 amps. Circuit conductors shall be sized per the table below. All power connections to the control panels shall be performed by a licensed electrician at the cost of this Contractor. Submit circuit information (total amperage on circuit, conductors length, and panel) for control panels to the Architect/Engineer for approval.

Circuit Load (Amps)	Circuit Max Length	Feeder Size
≤ 5	≤ 200ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 10	≤ 100ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 16	≤ 75ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 200	≤ 325ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 100	≤ 160ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 75	≤ 100ft	2#10 & 1#10 ground in 3/4" conduit.

L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.

M. Remodeling:

1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. If wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.

N. Labels For Control Devices:

1. Provide labels indicating service of all control devices in panels and other locations.
2. Labels may be made with permanent marking pen in the control panels if clearly legible.
3. Use engraved labels for items outside panel such as outside air thermostats.
4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.

O. VFDs:

1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.
2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.
3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.
4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.

5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

P. Airflow Stations:

1. The transmitter shall be installed at a location that is protected from weather, water, and vibration.
2. Mount transmitter where they can easily be read (36" to 66" above floor). Do not fasten transmitters directly to ductwork or compromise duct insulation.
3. The manufacturer's authorized representative shall visit the project site during construction prior to station installations to confirm all submitted sizes, mounting requirements and locations. Size adjustments shall be made at no additional cost. The representative shall meet on site with the TCC to support and train them on proper installation procedures and calibration.
4. Install labels at each sensor and transmitter identifying its service.

3.02 GRAPHIC DISPLAY

A. Create a customized graphic for each piece of equipment indicated on the itemized points list.

B. Components shall be arranged on graphic as installed in the field.

C. Include each graphic point listed in the itemized points list using real time data.

D. Provide a graphic representation of the following:

1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.
3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.
5. Show the location of each thermostat on the floor plan.
6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.

E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:

1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.

F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:

1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

3.03 CONDUIT AND BOXES INSTALLATION

A. Conduit and Box Installation: Refer to Electrical Section 26 0533 for execution and installation.

B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 26 0553 for raceway and box identification installation.

C. Outlet Box Schedule: Thermostat/temperature sensor:

1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.

2. Other Conditions: Refer to Electrical Section 26 0533 for requirements.

3.04 WIRE AND CABLE INSTALLATION

A. Wire and Cable Installation: Refer to Electrical Section 26 0513 for execution and installation.

B. Field Quality Control:

1. Inspect wire and cable for physical damage and proper connection.

2. Torque test conductor connections and terminations to manufacturer's recommended values.

3. Perform continuity test on all conductors.

4. Protection of cable from foreign materials:

a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

C. Installation Schedule:

1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

3.05 FMCS INSTALLATION

A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.

B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.06 COMMISSIONING

A. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.

C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.

D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.07 PREPARATION FOR BALANCING

A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).

B. Check the calibration and setpoints of all controllers.

C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.

D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.

E. Verify the operation of all interlock systems.

3.08 TEST AND BALANCE COORDINATION

A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.

C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.

D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

3.09 DEMONSTRATION AND ACCEPTANCE

A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

3.10 TRAINING

A. On-Site:

1. After completion of commissioning, the manufacturer shall provide 6 hours of training for 4 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

B. Day-to-Day Operations - Training Description:
   1. Proficiently operate the system.
   2. Understand control system architecture and configuration.
   3. Understand FMCS systems components.
   4. Understand system operation, including FMCS system control and optimizing routines (algorithms).
   5. Operate the workstation and peripherals.
   6. Log-on and off the system.
   7. Access graphics, point reports, and logs.
   8. Adjust and change system setpoints, time schedules, and holiday schedules.
   9. Recognize malfunctions of the system by observation of the printed copy and graphic visual signals.
   10. Understand system drawings and Operation and Maintenance manual.
   11. Understand the job layout and location of control components.
   12. Access data from FMCS controllers and ASCs.
   13. Operate portable operator's terminals.

C. Provide course outline and materials in accordance with the "SUBMITTALS" article in Part 1 of this section. The instructor(s) shall provide one copy of training material per student.

3.11 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.

F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.

END OF SECTION

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SECTION 23 0913
INSTRUMENTATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Thermometers.

B. Static and Differential Airflow Pressure Gauges.

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Dial Type:

1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
3. Stem lengths as required for application with minimum insertion of 2-1/2".
4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.
5. Manufacturer:
   a. Ashcroft
   b. Marsh
   c. Marshalltown
   d. Miljoco
   e. Tel-Tru
   f. Trerice
   g. U.S. Gauge
   h. Weiss
   i. Weksler, Wika.

B. Select scales to cover expected range of temperatures.

2.02 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES

A. Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.

B. Accuracy shall be ± 3% of full scale maximum throughout entire range at 70°F.

C. Provide mounting brackets, probes, and shutoff valves required for proper installation.

D. The range and service shall be as required for application or as noted on the drawings.

E. Manufacturers:

1. Dwyer Magnehelic Series 2000
2. Marshalltown Instrument Series 85C.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:

1. Install per manufacturer's instructions.
2. Coil and conceal excess capillary on remote element instruments.
3. Install gauges and thermometers in locations where they are easily read from normal operating level.
4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Thermometers:

1. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.
2. Locate duct thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

END OF SECTION

SECTION 23 2300
REFRIGERATION PIPING AND SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping and Pipe Fittings
B. Moisture and Liquid Indicators
C. Check Valves
D. Pressure Relief Valves
E. Filter-Driers
F. Suction Filters
G. Solenoid Valves
H. Expansion Valves
I. Receivers
J. Suction Accumulators

1.02 QUALITY ASSURANCE

A. Remanufactured specialties are not acceptable.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500.
B. Submit layout of entire piping system including equipment, critical dimensions, and all pipe sizes, traps, valves, and accessories. Layout shall be a custom drawing for this job, not a standard detail. The refrigeration equipment supplier shall stamp the approval on layout drawings.
C. Submit product data for specialties, including manufacturers catalog information.
D. Submit manufacturer's installation instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labels in place.
B. Protect piping and specialties from entry of foreign material by leaving caps and plugs in place until installation.

PART 2 - PRODUCTS

2.01 PIPING

A. Design Pressure: 450 psig.
    1. Maximum Design Temperature: 250°F.
B. Piping - 4" and under; Brazed Joint:
    1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
    2. Joints: Brazed with silver solder.
    3. Fittings: Wrought copper solder joint, ANSI B16.22.
    4. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.
C. Piping - 1-3/8" and Under; Dual Concentric Crimp Mechanical Press Connection (Contractor's Option):
    1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
    2. Joints: Dual concentric crimp band mechanical press connection.

3. Fittings: Refrigerant Grade Copper in accordance with ASTM B75 or ASTM B743 with embedded HNBR O-ring.
4. Manufacturers:
    a. Rapid Locking System (RLS)
    b. Conex Banninger
    c. Parker Hannifin
    d. MaxiPro ACR
    e. Nibco ACR Press

D. Piping - 1-3/8" and Under; Mechanically Attached, Axially Swaged Compression Connection (Contractor's Option):
1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
2. Joints: Mechanically attached connector, axially swaged compression connection.
3. Fittings: Refrigerant grade copper in accordance with ASTM B75 or ASTM B743. Brass body with two stabilization inserts in accordance with ASTM B15/B16M. Two steel rings in accordance with ASTM A108-13; anerobic adhesive sealant.
4. Manufacturers:
    a. VULKAN Lokring

2.02 MOISTURE AND LIQUID INDICATORS

A. UL listed, with copper, brass, or copper-plated steel body, flared or solder ends, extended fittings in units up to at least 1-1/8" to allow brazing without removing the cartridge, sight glass, color coded paper moisture indicator that is replaceable without breaking piping connections for units up to 1-1/8" size, and plastic cap; maximum working pressure of 500 psi, and maximum temperature of 200°F.
1. Manufacturers:
    a. Sporlan
    b. Henry Valve Company
    c. Alco Valve

2.03 VALVES

A. BA-14: Refrigerant Ball Valve: 3/8" thru 3-1/8", 500 psi, -40°F to +300°F, full-port up to 2-1/8" size, blow-out proof, PTFE seals, brass ball with equalizing orifice, visible position indication, seal cap, extended copper connections, replaceable stem seals, compatible with all CFC, HCFC, and HFC refrigerants.
1. Manufacturers:
    a. Henry Valve Company
    b. Superior Valve
    c. Alco Valve

2.04 CHECK VALVES

A. CK-10: 1/4" thru 3-5/8", 500 psi, globe or angle pattern, brazed, brass body, cleaned-dried-plugged and tagged at factory for refrigerant service.
1. Manufacturers:
    a. Henry Valve Company
    b. Mueller
    c. Wolf-Linde

2.05 PRESSURE RELIEF VALVES

A. RV-5: Straight Thru or Angle Type: Brass body and disc, Teflon seat, factory sealed and stamped with ASME UV and National Board Certification NB; selected to ANSI/ASHRAE 15.

2.06 FILTER-DRIERS

A. Replaceable Cartridge Angle Type: ANSI/AHRI 710, UL listed, brass or epoxy-coated steel shell, molded desiccant high-water capacity filter core(s); maximum working pressure of 500 psi; maximum temperature of 275°F; maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

B. Permanent Straight Thru Type: ANSI/AHRI 710, UL listed, steel shell with molded desiccant filter core, maximum working pressure of 500 psi, maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

2.07 SUCTION FILTERS

A. Replaceable Cartridge Angle Type: UL listed for 500 psi up to 2-18" size, and 400 psi for larger sizes, steel shell that passes 1000-hour salt spray test with copper fittings, replaceable pleated filter element(s); maximum pressure drops of 3 psi with R410a or 2 psi with R134a at system flow rate, capable of accepting molded desiccant core for cleanup after compressor burnout, access valve in the removable end plate. Install with side refrigerant inlet.

2.08 SOLENOID VALVES

A. Valve: AHRI 760; pilot operated; copper or brass body and internal parts; synthetic seat; stainless steel stem and plunger assembly; extended solder ends to permit installation without disassembly; maximum working pressure of 500 psi; normally closed. Maximum pressure drop at system flow of 5 psi for R410a and 3 psi for R134a.

B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, surge protector and color-coded lead wires, integral junction box, Class F temperature rated, ANSI/UL 429.

2.09 EXPANSION VALVES

A. Angle or Straight Thru Type: ANSI/AHRI 750; materials suitable for system refrigerant, external equalizer, adjustable super heat setting, balanced port design, suitable for horizontal or vertical installation, with replaceable capillary tube and remote sensing bulb.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10°F super heat. Select to avoid being undersized at full load or excessively oversized at part load.

2.10 RECEIVERS

A. All receivers shall have capacity to hold the entire refrigerant charge when 90% full at 90°F per ASHRAE 15-78.

B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 450 psi working pressure, with tappings for inlet, outlet, and relief valve or fusible plug.

C. Over 6" Internal Diameter: ANSI/AHRI 495, welded steel; ASME U or UM stamped for 400 psi, with tappings for inlet, outlet and pressure relief valve.

2.11 SUCTION ACCUMULATORS

A. All accumulators shall have capacity to hold 50% of the refrigerant charge when 90% full at 90°F per ASHRAE 15-78, pressure drop equivalent to under 0.5°F at peak capacity, a finish that survives a 500-hour salt spray test, vertical design with dip tube and screened oil inlet orifice, and a hot gas boil-out coil to evaporate liquid refrigerant.

B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 400 psi pressure rating, with tappings for inlet, outlet, and pressure relief valve or fusible plug.

C. Over 6" Internal Diameter: ANSI/AHRI 495, welded steel, ASME U or UM stamped for 450 psi, with tappings for inlet, outlet and pressure relief valve.

2.12 EXPANSION COMPENSATION

A. Assembly consisting of two flexible connectors, two copper flexible connectors, two 90° elbows, and a 180° return pipe. Unit shall be in the form of a pipe loop.

B. Connectors shall have corrugated copper hose bodies with copper braided casings.

C. Connectors shall be rated for 150 psi working pressure at 70°F.

D. Sizes 2" and smaller shall have copper sweat ends.

E. Connectors shall be suitable for 1/2" permanent misalignment.

F. Manufacturer:

1. Metraflex Type MLS

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories.

3.02 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

F. Group piping whenever practical at common elevations and locations. Slope piping 1% in direction of oil return.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access doors for concealed valves and specialties.

J. Where pipe support members are welded to structural building frame, brush clean, and apply zinc rich primer to welding.

K. Insulate piping per Section 23 0719.

L. Provide external equalizer piping on expansion valves, and locate expansion valve sensing bulb immediately downstream of evaporator on suction line. Connect distributor to expansion valve outlet.

M. Install flexible connectors parallel to the shafts of compressors.

N. Fully charge system with refrigerant after testing.

3.03 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.

B. All pipe, fittings, valves, equipment and accessories shall have factory applied identification sufficient to determine their conformance with specified requirements.

C. Exercise care at all times to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings.

F. Cut all pipe to exact measurement and install without springing or forcing.

3.04 APPLICATION

A. Provide solenoid valves in liquid lines of systems, in oil bleeder lines to stop flow of oil and refrigerant into the suction line when system shuts down, and in hot gas bypass lines, as applicable.

B. Provide refrigerant charging valve connections.

C. Provide replaceable cartridge filter-driers, with three-valve bypass assembly and suction filters without bypass assembly.

3.05 JOINING OF PIPE

A. Brazed Joints:

1. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
2. Flux shall conform to ANSI/AWS A5.31.
3. Remove composition discs and all seals during brazing if not suitable for a minimum of 840°F or greater than the melting temperature of the brazing filler metal, whichever is greater.

B. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Examination: Upon delivery to the jobsite, examine copper tubing and fittings for debris, defects, incise marks (manufacturer's engraving on tube), holes, or cracks.
3. Fully insert tubing into the fitting and mark tubing.
4. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
5. Joint shall be pressed with a tool approved by the manufacturer.
6. Installers shall be trained by manufacturer’s personnel or representative. Provide documentation upon request.

C. Axially Swaged Connection:

1. Brass axially swaged connectors shall be installed in accordance with the manufacturer's installation instructions.
2. Installers shall be trained by a certified Vulkan LOKRING trainer. Provide proof of certification upon request.

3.06 FIELD QUALITY CONTROL

A. Test piping system with nitrogen at 300 psig for at least 8 hours without loss of pressure.

B. Comply with ASHRAE Standard 147 for refrigerant system integrity testing.

C. After pressure testing, evacuate all refrigerant piping to at least 28" of mercury for 24 hours without loss of vacuum. Ensure moisture does not enter the piping prior to and during the tests.

END OF SECTION

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SECTION 23 3100
DUCTWORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Galvanized Ductwork
B. Stainless Steel Ductwork
C. Carbon Steel Ductwork
D. Ductwork Reinforcement
E. Ductwork Sealants
F. Rectangular Ductwork
G. Round and Flat Oval Ductwork
H. Flexible Duct
I. Grease Exhaust Duct
J. Dishwasher Exhaust Duct
K. Leakage Testing
L. Ductwork Penetrations
M. Painting

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500.
B. The Architect/Engineer may require field verification of sheet metal gauges and reinforcing to verify compliance with these specifications. At the request of the Architect/Engineer, the contractor shall remove a sample of the duct for verification. The contractor shall repair as needed.
C. Duct Layout Drawings: Submit detailed duct layout drawings at 1/4" minimum scale complete with the following information:
    1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
    2. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
    3. Room names and numbers, ceiling types, and ceiling heights.
    4. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
    5. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 23 0500.
D. Duct Leakage Test Summary Report: Upon completion of the pressure test described in Part 3, the Contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

1.03 DEFINITIONS

A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.
C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.

D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

1.04 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 23 0500 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

B. Duct drawings shall be at 1/4" minimum scale complete with the following information:

1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
3. Location and size of all duct access doors.
4. Room names and numbers, ceiling types, and ceiling heights.
5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.

PART 2 - PRODUCTS

2.01 SHAPE

A. Rectangular Duct - Single Wall:

1. General Requirements:
   a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
   b. Transitions shall not exceed the angles in Figure 4-7.
2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:
   a. All ducts shall be cross-broken or beaded.
   b. Snap lock seams are not permitted.
   c. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
      1) Type 1:
         a) Description: Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
         b) Usage: Limited to 3,000 fpm and vane lengths 36" and under.
      2) Type 2:
         a) Description: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
         b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

3) Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):
   a) Description: Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
   b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.
4) Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
5) Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.
6) Omitting every other vane is prohibited.

d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.

e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.

f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.

g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.

h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.

i. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.

j. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
   1) Apply sealant to all inside corners. Holes at corners are not acceptable.
   2) Manufacturers:
      a) Ductmate Industries - 25/35/45
      b) Nexus
      c) Mez
      d) WDCI
      e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

k. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
   1) Apply sealant to all inside corners. Holes at corners are not acceptable.
   2) Flanges shall be 24-gauge minimum (not 26 gauge).
   3) Manufacturers:
      a) Lockformer TDC
      b) TDF
      c) United McGill
      d) Sheet Metal Connectors
      e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

B. Round and Flat Oval Spiral Seam Ductwork - Single Wall:
1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
3. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
4. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
10. Transverse Joint Connections:
    a. Crimped joints are not permitted.
    b. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
    c. Ducts and fittings larger than 36" shall have flanged connections.
    d. Secure all joints with at least 3 sheet metal screws before sealing.
    e. Manufacturers:
       1) Slide-on Flanges:
       2) Ductmate Industries - SpiralMate

3) Accuflange
4) Sheet Metal Connectors are acceptable.

f. Manufacturers, Self-Sealing Duct Systems:
1) Lindab
2) Ward "Keating Coupling"

2.02 MATERIAL AND APPLICATION SPECIFIC

A. Galvanized Steel:
1. General Requirements:
a. Duct and reinforcement materials shall conform to ASTM A653 and A924.
b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
d. Ductwork reinforcement shall be of galvanized steel.
2. Duct Hangers and Support:
a. Ductwork supports shall be of galvanized or painted steel.
b. All fasteners shall be galvanized or cadmium plated.
c. Strap Hangers: Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel attached to the bottom of ducts with spacing as required by SMACNA.
d. Cable Hangers:
1) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork. Manufacturers; Supports:
a) Gripple
b) Ductmate
c) Duro Dyne
d) Architect/Engineer approved
e. Integral Corner Connector Hanger: Integral hanger and corner assembly for use with TDC/TDF style duct flanges. Die stamped offset hanger connects to the flanged corner assembly. For use with aircraft cable or 1/4" or 3/8" diameter threaded rods. Tested to hold up to 1,400 lbs. Install per manufacturer’s ratings and instructions.
1) Manufacturers; Supports:
a) EZ Hanger

B. Stainless Steel Ductwork:
1. General Requirements:
a. Ductwork shall be Type 304L stainless steel, 16 gauge minimum.
b. Exposed ductwork shall have a #3 finish. Concealed ductwork may have milled finish.
c. Ductwork reinforcement shall be of stainless steel.
2. Duct Hangers and Supports:
a. Ductwork supports shall be of stainless steel. Slip cable hangers are acceptable.
1) Manufacturers, Supports:
a) Gripple
b) Ductmate

c) Duro Dyne

d) Architect/Engineer approved

b. All fasteners shall be cadmium plated or stainless steel.

C. Carbon Steel Ductwork:

1. Ductwork shall be black carbon steel. Refer to Grease Exhaust Duct below for thicknesses.

D. Grease Exhaust Duct:

1. Field Fabricated

a. Exposed ductwork shall be 16 gauge minimum, Type 304L stainless steel. Concealed ductwork may be 16 gauge black steel.

b. Concealed Ductwork:

1) Range hood/grease exhaust ducts having an area of 4 sf or less shall be 16 gauge carbon steel.

2) Range hood/Grease exhaust ducts having an area greater than 4 sf shall be 14 gauge carbon steel.

c. All joints and fittings shall be continuously welded and liquid-tight.

d. Exposed ductwork shall have a #3 finish. Concealed ductwork may have a mill finish.

e. Do not penetrate fire rated partitions, unless protected as required by applicable codes.

f. Provide pre-fabricated access doors and labels required by NFPA 96 on sides of duct at least 1.5" from bottom. Provide access at each change in direction and at maximum 20-foot intervals in horizontal ducts. Provide access at every floor for vertical ducts.

g. Install grease traps in kitchen grease and dishwasher ducts at base of all vertical risers and low points in the system.

h. Where grease ducts are 20" x 20" or larger, install access for personnel to enter duct. Duct supports must be sized to support the duct weight and an additional 800 lbs. per NFPA 96.

i. Install ducts with proper clearance to combustible and limited-combustible materials.

j. Grease exhaust duct doors shall be grease and airtight, UL 1978 listed, meet NFPA 96 standards, and all mechanical codes. Grease duct access doors can be sandwich type or with a weld-on frame, with/without hinge.

1) Manufacturer, Duct Doors:

a) Ductmate Industries "Ultimate I" or "Ultimate II" Style door

b) Approved equal

k. All grease duct access doors used must be accompanied by independent testing in conjunction with each manufacturer's respective wrap system for high temperature applications.

l. Refer to Section 23 0713 for duct insulation material and insulated access door when required to provide proper enclosure of ductwork.

E. Dishwasher Exhaust Duct:

1. Ductwork shall be 16 gauge minimum Type 304L stainless steel.

2. All joints and fittings shall be continuously welded and liquid-tight.

3. Ductwork exposed in kitchens shall have a #3 finish. Concealed ductwork may have a standard mill finish.

4. Do not penetrate fire rated partitions, unless protected as required by applicable codes.

2.03 DUCTWORK REINFORCEMENT

A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.

1. Ducts must be over 18" wide.
2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
3. Tie rods must not exceed 1/2" diameter.
4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.04 DUCTWORK SEALANTS

A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M.

2.05 FLEXIBLE DUCT

A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.

B. Flame Spread/Smoke Developed: Not over 25/50.

C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.

D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.

E. Acoustic:

1. Flexible duct shall be acoustic rated in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL. Insertion loss values noted below are for flow velocities less than 2,500 fpm. Submittals shall include insertion losses ratings per sizes and lengths listed below regardless of sizes shown on the drawings.
2. Flexible have corrosion-resistant wire helix, bonded to a nylon fabric core inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.
3. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft2*ºF*hr/Btuh. Temperature range of at least 0-180ºF. Maximum velocity of 4,000 fpm.
4. Minimum Acoustic Insertion Losses per octave band:
   a. Straight Duct:

Diameter	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	4.0	13	15	15	16	17	16
6" ø	3 ft	2.3	4.9	5.3	5.3	5.5	5.8	5.4
8" ø	6 ft	5.7	14	13	15	16	18	16
8" ø	3 ft	2.9	5.0	4.9	5.7	5.6	5.8	5.6
12" ø	6 ft	5.5	13	12	15	15	18	13
12" ø	3 ft	2.8	4.8	4.7	5.3	5.3	5.8	4.9

b. 90 degree Elbow:

Diameter	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	10	15	16	17	18	17	18
6" ø	3 ft	3.8	5.4	5.5	5.7	5.9	5.8	5.9
8" ø	6 ft	10	15	16	17	16	18	18
8" ø	3 ft	2.4	5.3	5.6	5.8	5.6	5.9	6.0
12" ø	6 ft	11	14	15	16	15	16	15
12" ø	3 ft	4.4	5.1	5.3	5.5	5.4	5.6	5.3

5. Usage:
   a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
   b. Connections to air inlets and outlets. Do not exceed 6'-0" in length.
   c. Acceptable Manufacturers:
      1) Flexmaster USA - Type 6
      2) Thermaflex M-Ke

F. Radius Forming Elbows:
1. Flexible plastic radius forming elbow for use with flexible ducts to create 90deg elbow. One size for 6" to 16" diameter ducts. UL listed for return plenum spaces.
2. Usage: All supply air terminals with flexible ductwork connection.
3. Installation: Attach to flex duct and secure draw bands without crushing flex duct to form smooth radius elbow. Suspend radius forming elbow to structure. Install per manufacturer’s instructions.
4. Acceptable Manufacturers:
   a. Hart & Cooley - Smartflow
   b. Thermaflex - Flexflow
   c. Titus - Flexright

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide openings in ducts for thermometers and controllers.
B. Locate ducts with space around equipment for normal operation and maintenance.
C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
E. Supply ductwork shall be free of construction debris, and shall comply with Level "B" of the SMACNA Duct Cleanliness for New Construction Guidelines.
F. Repair all duct insulation and liner tears.
G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
H. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.

I. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.

J. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.

K. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible.

L. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.

M. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

N. Kitchen Grease and Dishwasher Ductwork:

1. All kitchen grease and dishwasher ductwork shall be installed with a continuous slope and grease tight welds on all seams and joints.

3.02 DUCTWORK APPLICATION SCHEDULE

A. General:

1. Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual
2. Insulation:
   a. Refer to Section 23 0713 for insulation types.
   b. Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).

B. AHU-1 Supply Duct from Fan to Terminal Air Boxes - Single Wall:

1. Shape:
   a. Rectangular Duct - Single Wall
   b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: +3"
4. Seal Class: A
5. Insulation:
   a. 1-1/2" thick Type A (R=4.5)
6. Additional Requirements: None

C. Supply Duct from Terminal Air Boxes to Outlets:

1. Shape:
   a. Rectangular Duct - Single Wall
   b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: +2"
4. Seal Class: A
5. Insulation:
   a. 1-1/2" thick Type A (R=4.5)
6. Additional Requirements: None

D. DOAS-1 from Fan to Outlet:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: +2"
   4. Seal Class: A
   5. Insulation:
      a. 1-1/2" thick Type A (R=4.5)
   6. Additional Requirements: None

E. Return Duct:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation:
      a. None
   6. Additional Requirements: None

F. General Exhaust Duct:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation: None
   6. Additional Requirements: None

G. Combustion Air Duct:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -1"
   4. Seal Class: A
   5. ASHRAE 90.1-2019 and IECC-2021
      a. Insulation: 1 1/2" thick Type B (R=6.0)
   6. Additional Requirements: None

H. Relief/Exhaust Air Duct from Fan to Exhaust Outlet:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: +2"
   4. Seal Class: A
   5. Insulation:
      a. 1-1/2" thick Type A (R=4.5)

I. Grease Exhaust Duct:
   1. Shape: Refer to "Grease Exhaust Duct"
   2. Material: Field Fabricated
   3. Pressure Class: -3"
   4. Seal Class: A
   5. Insulation: Type F.

J. Dishwasher Exhaust Duct:
   1. Shape: Refer to "Dishwasher Exhaust Duct"
   2. Material: Dishwasher Exhaust Duct
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation: 1-1/2" thick Type A (R=4.5)

K. Outside Air Intake from Louver to Heating Coil:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation: 1 1/2" thick Type B (R=6.0)

L. Relief Air Louver to Backdraft Damper:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: +2"
   4. Seal Class: A
   5. Insulation:
      a. 1 1/2" thick Type B (R=6.0)

M. Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.):
   1. Insulation:
      a. 1-1/2" thick Type A (R=4.5)

3.03 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

3.04 TESTING

A. Interior Duct - Less than 3" WG (positive or negative):

1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

B. Interior Duct - 3" WG and Above (positive or negative):

1. Duct system shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

C. Test Procedure:

1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
    a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.
    b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
    c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
    d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
    e. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.

f. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.

g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.

i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

D. Grease Exhaust Duct:

1. A light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open to emit light equally in all four directions.

2. Testing of the entire exhaust duct system including the hood-to-duct connection shall be performed. Ductwork shall be permitted to be tested in sections provided every joint is tested.

3. Leakage testing shall occur prior to use or concealment of the duct system. Ducts shall be considered concealed where installed in shafts or covered by insulation or wrap that prevents ductwork from being visibly inspected on all sides. The test shall be performed in the presence of the code official.

3.05 DUCTWORK PENETRATIONS

A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.

B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.

C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

3.06 PAINTING

A. Paint interior of ducts black within twice the largest duct dimension of inlets and outlets where interior of duct is visible.

END OF SECTION

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SECTION 23 3300
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Manual Volume Dampers.

B. Fabric Connectors.

C. Duct Access Doors.

D. Duct Test Holes.

E. Duct Silencers.

F. Temperature Control Dampers.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500.

B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 MANUAL VOLUME DAMPERS

A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.

B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.

C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.

E. Provide locking quadrant regulators on single and multi-blade dampers.

F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

2.02 FABRIC CONNECTORS

A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.

B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.

C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.

D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.

E. All corners shall be folded, sealed with mastic and stapled on 1" centers.

F. Fabric connectors shall not be painted.

G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.

H. Materials:

1. Durodyne MFN-4-100
2. Vent Fabrics, Inc.
3. "Ventglas"
4. Proflex PFC3NGA

2.03 DUCT ACCESS DOORS

A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.

B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.

C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

D. Access doors with sheet metal screw fasteners are not acceptable.

E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.

F. Provide duct access door in all horizontal return ductwork at 20 foot intervals per NFPA 90A.

2.04 GREASE DUCT ACCESS DOORS

A. Provide pre-fabricated and pre-insulated duct access doors by the same manufacturer as the fire resistive duct wrap.

2.05 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.06 DUCT SILENCERS

A. Straight Silencer

1. All silencers shall be factory fabricated by the same manufacturer, except that 'No-Loss" silencers (thicker than normal double-wall ducts) may be Contractor fabricated.
2. Duct silencers shall have length, air pressure drop, and self-generated sound ratings not to exceed the values scheduled on the drawings. Dynamic insertion ratings shall not be less than those scheduled on the drawings. Silencer inlet and outlet dimensions must match the sizes on the drawings. Transitions are not acceptable unless shown on the drawings.
3. All silencer ratings shall be determined in accordance with the ASTM E477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.
4. Silencers shall be constructed of galvanized steel, have 26 gauge minimum perforated interior (22 gauge for transitional silencers), be able to withstand 8" of positive and 4" of negative pressure, and shall have inorganic, bacteria, and fungus resistant glass fiber filler with not less than 5% compression. Silencers shall meet SMACNA standards for the duct pressure class specified.
5. Fiberglass cloth or other scheduled liners shall completely separate the media from the airstream.
6. Silencers shall not exceed 25/50 flame spread/smoke developed per ASTM E84, NFPA 255, or UL 723.
7. Manufacturers:
    a. Vibro-Acoustics
    b. VAW
    c. United McGill
    d. Semco
    e. Ruskin Sound Control (Rink)
    f. Dynasonics
    g. Price
    h. All silencers shall be by the same manufacturer

2.07 DUCTWORK ACCESSORY SEALANTS

A. Ductwork accessory sealants and adhesives shall conform to Section 23 3100.

2.08 CONTROL DAMPERS AND DAMPER ACTUATORS

A. Control dampers and damper actuators shall be furnished by the Temperature Control Contractor (Section 23 0900) and shall be installed by this Contractor.

B. Coordinate exact sizes, locations, and installation requirements with the Temperature Control Contractor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.
2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Grease duct access doors shall be installed per approvals from manufacturer's ICC-ES Evaluation Report.
6. Provide duct test holes where indicated and as required for testing and balancing purposes.

B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing.
2. Provide ceiling access doors for manual volume dampers.

C. Control Dampers and Damper Actuators:

1. Install control dampers and damper actuators in accordance with manufacturer's instructions and in coordination with the Temperature Control Contractor.
2. Seal around damper frame inside ductwork with duct sealant to prevent bypass around damper.
3. Provide duct access door at each control damper.

END OF SECTION

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SECTION 23 3423
POWER VENTILATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Roof Exhaust Fan.

B. Rooftop Fan Curbs.

1.02 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300.

C. Fabrication: Conform to AMCA 99.

D. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.

B. Submit manufacturer's installation instructions.

C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.04 EXTRA STOCK

A. Provide one (1) extra belt set for each fan unit.

PART 2 - PRODUCTS

2.01 ROOFTOP EXHAUST FAN - BELT DRIVEN

A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.

B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.

C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.

E. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.

F. Motor mounted outside of air stream and ventilated with outside air. Motor not less than 1/3 HP.

G. Aluminum or brass bird screen. Plastic mesh will not be allowed.

H. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.

I. Furnish normally closed, electric motorized damper. Provide step down transformer if required. Install and wire damper to open when fan runs.

J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods. Leakage shall not exceed 4 cfm/sq.ft @1" SP (or shall be AMCA Class 1 certified).

K. Mill aluminum finish.

L. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.

M. Manufacturers:
1. Aerovent "FACX"
2. Cook "ACE-B"
3. Greenheck "GB"
4. Carnes "VEB"
5. PennBarry DX
6. ACME PV
7. ILG CRB
8. Twin City BCRD
9. York

2.02 ROOFTOP EXHAUST FAN - VERTICAL DISCHARGE - BELT DRIVEN

A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backwards inclined blades, statically and dynamically balanced.

B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.

C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

D. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.

E. Motor mounted outside of air stream and ventilated with outside air. Motor not less than 1/3 HP.

F. Aluminum or brass bird screen. Plastic mesh will not be allowed. Do not provide/install for kitchen/grease hood applications.

G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.

H. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.

I. Include ventilated curb cap and hinged base with restraining means.

J. Furnish normally closed, electric motorized damper. Furnish step down transformer if required. Install and wire damper to open when fan runs. Do not provide/install for kitchen/grease hood applications.

K. All fans serving range hoods shall have extended shrouds to discharge at least 40" above roof and built-in grease trough with drain.

L. Mill aluminum finish.

M. Manufacturers:
1. ACME
2. Cook
3. Greenheck
4. PennBarry
5. Twin City
6. Jenco
7. Soler-Palau
8. York

2.03 ROOFTOP FAN CURBS

A. Furnish and install prefabricated roof curbs for all rooftop fans.

B. Size curb to match the curb cap of fan.

C. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

D. Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer.

E. 14-gauge aluminum construction.

F. Curb without cant.

G. Manufacturers:

1. Same manufacturer as the fan
2. Pate
3. RPS
4. Thy

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated lag screws to roof curb.

C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.

D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION

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SECTION 23 3600
AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single Duct Variable Air Volume Terminal Box.

B. Fan Powered Variable Air Volume Terminal Box.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.

D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Submit manufacturer's installation instructions.

1.03 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.01 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

A. All units shall have noise data certified in accordance with AHRI Standard 885-98 with 5/8" 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Acoustical considerations shall take priority over sizes noted in schedule. It is the manufacturer's responsibility to increase inlet size to meet acoustic levels scheduled.

2.02 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Minimum 22 gauge galvanized steel.

1. Fully insulated with 3/4" elastomeric closed cell insulation liner. Insulation shall be UL listed and meet NFPA 90A requirements.

a. Usage: All supply air systems.

B. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

C. Inlet Flow Sensor: Provide "cross" or "ring " style velocity and static sensor at inlet to box for use by unit controller.

D. Damper Operators: Electronic. Furnish all mounting brackets, relays, and linkages. Provided and installed by the TCC in the field.

E. Electronic Volume Regulator/Controller: Provided and installed by the TCC in the field. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Set boxes for maximum and minimum settings shown on the drawings.

F. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cutout primary safety device, manual reset thermal cutout secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing, SCR control. Capacity and voltage shall be as scheduled on the drawings.

G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.

H. Refer to control diagrams and notes on control drawings for complete sequence of control.

I. Manufacturers:

1. Carrier
2. Titus
3. Trane
4. Krueger
5. Carnes
6. E.H. Price
7. Tuttle & Bailey
8. Nailor
9. Enviro-Tec
10. Johnson Controls Inc.
11. Metalaire.
12. Anemostat.

2.03 FAN POWERED VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Parallel minimum 22 gauge galvanized steel. Factory mounted access panel to provide access to air valve and fan.

B. Insulation:

1. Fully insulated with 3/4" elastomeric closed cell insulation liner. Insulation shall be UL listed and meet NFPA 90A requirements.

a. Usage: All supply air systems.

C. Fan: FC style, galvanized steel fan wheel. Fan housing shall be 22 gauge steel and fan board shall be 18 gauge steel. Motors shall be permanently lubricated, direct drive, permanent split capacitor type motor. Maximum motor temperature rise on all speeds of 50°F. Fan motor voltage shall be as scheduled on the drawings.

D. Damper Blades: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

E. Inlet Flow Sensor: Provide "cross" or "ring" style velocity and static sensor at inlet to box for use by unit controller.

F. Damper Operators: Electronic. Furnish all mounting brackets, relays, and linkages. Provided and installed by the TCC in the field.

G. Electronic Volume Regulator/Controller: Provided and installed by the TCC in the field. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Set boxes for maximum and minimum settings shown on the drawings.

H. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cut-out primary safety device, manual reset thermal cut-out secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing, **SCR** control. Capacity and voltage shall be as scheduled on the drawings.

I. Fan Inlet: Flanged inlet for field installed ducted return and filter.

J. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.

K. Refer to control diagrams and notes on control drawings for complete sequence of control.

L. Manufacturers:

1. Carrier
2. Titus
3. Trane
4. Krueger
5. Carnes
6. E.H. Price
7. Nailor
8. Enviro-Tec
9. Johnson Controls Inc.
10. Anemostat.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure. Do not support from adjacent ductwork.

E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.

F. Comb fins on coils to repair bent fins.

3.02 ADJUSTING

A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION

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SECTION 23 3700
AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grilles And Registers.

B. Architectural Square Panel Diffusers.

C. Louvers.

D. Roof Hoods.

E. Roof Curbs.

F. Goosenecks.

1.02 QUALITY ASSURANCE

A. Test and rate performance of air inlets and outlets per ASHRAE 70.

B. Test and rate performance of louvers per AMCA 500L-99.

C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 23 0500.

B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.

C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.

D. Submit manufacturer's installation instructions.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

B. Conform to ASHRAE 90.1.

PART 2 - PRODUCTS

2.01 AIR TERMINALS - GRILLES AND REGISTERS

A. Reference to a grille means an air supply, exhaust or transfer device without a damper.

B. Reference to a register means an air supply, exhaust or transfer device with a damper.

C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.

D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

E. The capacity and size of the unit shall be as shown on the drawings.

F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .

G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.

H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.

I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.

J. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.

K. Manufacturers:

1. Tuttle & Bailey
2. Titus
3. Price
4. Nailor
5. Carnes
6. Metalaire
7. Krueger
8. Anemostat
9. Raymon Donco

2.02 AIR TERMINALS - ARCHITECTURAL SQUARE PANEL DIFFUSERS

A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.

B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.

C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

D. The capacity and size of the unit shall be as shown on the drawings.

E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect.

F. Diffusers shall be architectural solid square panel and flush with ceiling.

G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge aluminum with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.

H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).

I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.

J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)

K. Manufacturers:

1. Tuttle & Bailey
2. Titus
3. Price
4. Nailor
5. Carnes
6. Metalaire
7. Krueger
8. Anemostat
9. Raymon Donco

2.03 LOUVERS - FIXED - ALUMINUM

A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.

B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.

C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.

D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.

E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.

F. Contractor shall provide the Division 3 Contractor with the correct sizes and locations of all louvers required in masonry walls.

G. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.

H. Louvers shall be suitable for duct connection.

I. Manufacturers:

1. Air Flow - "EA-403"
2. Arrow - "EA-415-D"
3. American Warming & Ventilating - "LE-21"
4. Construction Specialties - "A4097"
5. Dowco - "DBE-4"
6. Louvers & Dampers, Inc. - "IL-23"
7. Ruskin - "ELF375DX"
8. Vent Products - "2760"
9. Greenheck - ESD "403"
10. Pottorff - EFD
11. United Enertech FL-D-4
12. Anemostat
13. Arrow

2.04 ROOF HOODS

A. Hoods shall be constructed of roll formed, interlocking aluminum panels. Vertical end panels are fully locked into hood.

B. Top of curb to hood inlet shall be minimum of 5".

C. Curb cap shall be of 14 gauge formed aluminum with mitered corners continuously heliarc-welded. Hood shall be of the same material and cross-broken for added strength.

D. Hoods shall be furnished with aluminum bird screen.

E. Hood and throat shall be reinforced with extruded aluminum angle and have a minimum snow load rating of 30 lbs. per square foot.

F. Size, cfm, finish and pressure drop for hoods shall be as scheduled on the drawings.

G. Inlet area shall be minimum 150% of throat area for intake hoods. Outlet area shall be minimum 125% of throat area for exhaust hoods and relief vents.

H. Hoods shall be furnished with 12" high curb (above top of roof) and be of the size and type as shown on the drawings.

I. Hood shall be furnished with motorized damper unless otherwise noted on the drawings.

J. Manufacturers:
1. Ammerman
2. Carnes
3. Cook
4. Greenheck
5. ILG
6. Jenco Fan
7. PennBarry
8. Twin City Fan & Blower
9. York
10. United Enertech GEV-GIV

2.05 ROOF CURBS

A. Furnish and install, where shown on the drawings, prefabricated roof curbs for all rooftop hood openings.

B. Roof Mounting Curb: Curb shall be sized to match curb cap of the hood. Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

C. Curbs shall be unitized construction, 18 gauge galvanized steel, with continuous arc welded corner seams, insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board and damper support angle.

D. Curb without cant - suitable for use with membrane type roof.

E. Manufacturers:
1. Same manufacturer as the equipment it serves or Pate, RPS, or Thy.

2.06 GOOSENECKS

A. Fabricate in accordance with SMACNA Duct Construction Standards of minimum 18 gauge galvanized steel.

B. Mount on minimum 12 inch high curb base.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:
1. Install items in accordance with manufacturers' instructions.
2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
3. Install diffusers to ductwork with air tight connections.
4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
5. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.

B. Volume Damper:
1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

C. Roof Hood:
1. If manufacturer has no recommendations, secure roof hoods to curbs with 1/4" lag bolts on 8" maximum centers.

D. Maintaining Duct Cleanliness:

1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 23 0500.

END OF SECTION

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SECTION 23 4000
AIR CLEANING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Filters and Filter Media.

B. Filter Gauges.

1.02 QUALITY ASSURANCE

A. Filter media shall be tested under ANSI/UL 900 and labeled.

B. Provide all filters and filter banks by one manufacturer.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include data on media, performance, assembly and frames.

1.04 EXTRA STOCK

A. Provide a total of three (3) sets of filters for all units.

1. Provide clean filters in all units at time of installation.
2. Provide clean filters in all units at project final completion after all interior finishes are complete.
3. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

PART 2 - PRODUCTS

2.01 MERV 4 (FIBERGLASS THROWAWAY) - TYPE B

A. 1" thick fiberglass media with rigid frame and grille, minimum 20% efficiency per ASHRAE Standard 52.1 or MERV 4 per ASHRAE 52.2.

2.02 MERV 8 (MEDIUM EFFICIENCY) - DISPOSABLE - TYPE D

A. Non-woven cotton fabric, pleated media, disposable type with welded wire grid support bonded to the filter media.

B. Heavy duty, paper board frame with diagonal support members bonded to inlet and exit sides of each pleat. Bond frame to media periphery to eliminate air bypass.

C. 2" thick media with at least 4.6 square feet of media per square foot of face area. Maximum initial resistance of 0.30" WGat 500 fpm face velocity.

D. 25-30% efficiency and 90-92% arrestance per ASHRAE 52.1 or MERV 8 per ASHRAE 52.2.

2.03 MERV 13 (85% EFFICIENT) RIGID FILTER - DISPOSABLE - TYPE F

A. Pleated, rigid, disposable type with high density, fine fiberglass laminated to non-woven synthetic backing. Welded wire grid media support bonded to the filter media. Galvanized steel enclosing frame bonded to media periphery to eliminate air bypass.

B. Maximum 12" thick cartridges with at least 14.5 square feet of media per square foot of face area.

C. 80-85% efficiency and 98% arrestance per ASHRAE 52.1 or MERV 13 per ASHRAE 52.2. Maximum 0.60" WG initial resistance at 500 fpm face velocity.

D. Manufacturers:

1. Camfil
2. Flanders
3. American Air Filter

2.04 FILTER GAUGES

A. Differential Pressure Gauge: Diaphragm actuated, nominal 3" round dial, glass filled nylon housing, polycarbonate lens, zero adjustment, 0-2" W.G. range, 5% of full scale accuracy.

B. Accessories: Static pressure tips with integral compression fittings and 1/8" NPT plastic tubing.

C. Manufacturers:

1. Dwyer "Minihelic II" 2-5000
2. Marshalltown Instrument "Series 85C"

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all products per manufacturers' instructions.

B. Seal filter media to prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan systems without filters.

D. Install static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and calibrate. Every filter bank, including packaged units, shall have a filter gauge.

END OF SECTION

SECTION 23 6213
AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Condensing Unit Package.

B. Charge of Refrigerant and Oil.

C. Controls and Control Connections.

D. Refrigerant Circuit.

E. Motor Starters.

F. Electrical Power Connections.

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500 indicating components, assembly, dimensions, weights and loadings, required clearances, location and size of field connections, rated capacities, and electrical nameplate data. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system. Piping diagrams shall apply specifically to this job. Include description of capacity control logic and interface with building control system.

B. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

C. Submit operation and maintenance data including start-up instructions, maintenance instructions, parts lists, controls, and accessories.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage. Protect coils.

1.04 WARRANTY

A. Provide a one-year parts and labor warranty. Compressors shall have an additional four year warranty covering all material and labor costs for compressor repair or replacement at the Owner's option.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. Units: Self-contained, packaged, factory assembled and wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, and screens.

B. Construction and Ratings: In accordance with AHRI 210/240 and ANSI/UL 207 and 303. Testing shall be in accordance with ASHRAE 14.

C. Performance Ratings: EER and COP meeting ANSI/ASHRAE 90.1.

2.02 CASING

A. House components in welded steel frame with galvanized steel panels with painted finish meeting ASTM B117 salt spray test standard.

B. Mount starters, disconnects, and controls in weatherproof panel with full opening access doors.

C. Provide gasketed removable access doors or panels with quick fasteners.

2.03 CONDENSER COILS

A. Aluminum fins mechanically bonded to seamless copper tubing. Provide 12°F of refrigerant subcooling at design conditions.

B. Provide hail guards on all condenser coils.

2.04 CONDENSER FANS AND MOTORS

A. Vertical discharge direct drive propeller type condenser fans with fan guards.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in thermal overload protection.

C. Dynamically and statically balanced fans.

D. Separate motors for each fan.

2.05 COMPRESSORS

A. Construction: Semi-hermetic or hermetic scroll type with suction and discharge valves.

B. Mounting: Dynamically balance rotating parts and mount on vibration isolators.

C. Lubrication System: Oil pump with oil charging valve, oil level sight glass, oil filter, and magnetic plug or strainer.

D. Capacity Reduction Equipment: Multiple compressors, and/or multi-speed or variable-speed compressors.

E. Motor: Suction gas cooled with electronic sensor and winding over temperature protection.

F. Crankcase Heater: Evaporates refrigerant in crankcase during shutdown.

G. Suitable for operating on voltages plus or minus 15% of nameplate ratings.

2.06 REFRIGERANT CIRCUIT

A. Refrigerant may be new or reclaimed, and shall meet ARI-700-2004 Standard for Refrigerant Purity.

B. Provide each unit with the number of refrigerant circuits needed to provide the scheduled unloading and properly transport oil.

C. Provide the following for each refrigerant circuit:

1. Replaceable core type filter dryer.
2. Liquid line sight glass and moisture indicator.
3. Thermal expansion valve.
4. Insulated suction line.
5. Suction and liquid line service valves.
6. Schraeder valve.
7. Condenser pressure relief valve.
8. Suction filter.
9. Liquid line solenoid valve.

D. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

2.07 CONTROLS

A. On unit, mount NEMA 4 steel control panel containing power and control wiring, factory wired with single point power connection.

B. For each compressor, provide across-the-line starter, factory wired non-fused disconnects, non-recycling compressor overload, starter relay, and control power transformer. For each condenser fan, provide across-the-line starter with starter relay.

C. Provide the following safety controls arranged so operating any one will stop unit:

1. Manual reset high discharge pressure switch for each compressor.
2. Automatic reset low suction pressure switch for each compressor.
3. Manual reset oil pressure switch.

D. Provide the following operating controls:

1. Timer(s) that prevents compressor short cycling.
2. Low ambient temperature (as scheduled) thermostat to lock out compressor.
3. If discharge or return air control is provided with the unit, provide adjustable time delay between stages of operation. All units shall be compatible with direct control of staging by DDC systems. Suction pressure control of staging is not acceptable.
4. Pump down control that activates when the lead compressor of each circuit stops.
5. Hot gas bypass sized for minimum compressor loading, or "Frostat" control. If hot gas is used, the pipe with modulating flow (hot gas or suction) must pitch continuously downward in the direction of flow.
6. Thermostat to cycle fan motors in response to head pressure.
7. Head pressure controlled damper or variable speed fan control on first stage condenser fan. Rated for starting at 0°F.

2.08 MANUFACTURERS

A. Trane

B. York

C. Daikin

D. Carrier

E. Units shall be of the same manufacturer as the evaporator coil.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comb all condenser coils to repair bent fins.

C. Install on vibration isolators as scheduled on the drawings or in Section 23 0548.

D. Connect to refrigeration piping and evaporators.

3.02 MANUFACTURER'S FIELD SERVICES

A. Provide initial start-up by factory authorized service representatives. Adjust units to provide proper superheat.

B. Supply initial charge of refrigerant and oil for each refrigerant circuit. Replace losses of refrigerant and oil during the warranty period.

END OF SECTION

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SECTION 23 7313
INDOOR MODULAR AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Modular Indoor Handling Units.

1.02 QUALITY ASSURANCE

A. AHU Unit: Manufacturer specializing in design and manufacturing of the products specified in this section.

B. Fabrication: Conform to AMCA 99 and AHRI 430.

C. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

D. Sound Ratings: Tested to AMCA 300.

E. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

F. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.

G. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.

H. Unit shall contain only UL listed components.

I. Conform to ASHRAE 90.1.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

1. Product Data

   a. Include data on all fans and accessories. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.

   b. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops

   c. Submit sound power level data for both fan outlet and casing radiation at rated capacity.

   d. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions

   e. Submit manufacturer's data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.

   f. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.

B. Submit manufacturer's installation instructions.

C. All base bid pricing shall be based on the drawings, schedules and this specification

1. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices on the bid form. These voluntary prices will not be used in determining the low bidder.

2. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Architect/Engineer prior to the award of the air handling unit bid and before the submittal process begins.

D. Any exceptions to the specifications must be clearly noted to the Architect/Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.

G. Piezometer Flow Coefficients: Submittals for fans shall clearly indicate the size and associated flow coefficient for each fan included in the submittal as it relates to the piezometric airflow measuring system. Provide instructions indicating how the flow coefficient can be used in calculating fan airflow using the fan manufacturer provided empirically derived formulas for calculating airflow. Include recommended differential pressure controller ΔP range (inches w.g based on scheduled maximum airflows.

1.04 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.

B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.06 WARRANTY

A. Provide a manufacturer's 1-year parts and labor warranty against defects in material and workmanship.

1.07 GENERAL DESCRIPTION

A. Unit Location:

1. The air handling unit (AHU-1) is a variable air volume modular unit, located in a non-conditioned mechanical penthouse.
2. The dedicated outside air handling unit (DOAS-1) is a variable air volume modulate unit, located in a non-condition mechanical penthouse.
3. The unit will be set on a concrete housekeeping pad by the Contractor.

B. Building Type: The building is a steel structure with a cast-in-place concrete floor system on steel wide flange beams. The building exterior is a precast wall panel system. (AHU-1, DOAS-1)

C. Unit Description:

1. The unit shall contain all the components described in these specifications and shown on the drawings and schedules.
2. Refer to air handling unit drawings and schedules for additional information

PART 2 - PRODUCTS

2.01 MODULAR INDOOR AIR HANDLING UNITS

A. Manufacturers

1. Trane - Performance Climate Changer.
2. Daikin - Vision.
3. Carrier - 39 Series.
4. JCI/York - Solutions.
5. Air Flow Equipment - Wolverine.
6. Ventrol - ITF Indoor Unit.
7. Temtrol - Series ITF.

B. Housing:

1. Minimum 18 gauge G60 galvanized steel exterior panels reinforced and braced with galvanized steel framework.
2. Removable access panels for coil and fan removal.
3. Unit shall be double wall insulated constructed panel. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel. Cover all portions of the interior of the unit exposed to the airstream with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor is responsible for covering exposed insulation with galvanized sheet metal. The minimum R-value of the panel assemblies shall be 8.
4. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
5. Units shall be draw-thru or blow-thru as noted on the drawings and shall not exceed the overall dimensions.

C. Doors:

1. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls.
2. Doors shall contain a continuous neoprene bulb type gasket.
3. Each door shall contain a double pane tempered, reinforced or safety glass window.
4. Each door shall have a minimum of two (2) high compression type latches, operable from both sides.
5. Unit shall have full height, galvanized, double wall, and hinged, removable access doors on both sides of fan.

D. Access Sections:

1. Provide access sections as shown on the drawings between unit sections. Provide access doors as shown on plans.

E. Fan:

1. Direct Drive Single Width, Single Inlet Plenum with Airfoil Blades:
   a. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type.
   b. Statically and dynamically balanced.
   c. Grease lubricated ball bearings selected for 200,000 hours L-50 life at the design operating conditions.
   d. Provide extended lubrication lines for all bearings to an easily accessible location.
   e. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.
   f. Fan(s) shall have internal spring isolators.
   g. Piezometer Air Flow Measuring: Provide fan with factory installed piezometer ports for monitoring the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Ports shall be installed by the factory to ensure proper location of the taps to match how the fans were tested. Orifices shall be factory drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall extend to a termination plate mounted on the fan housing. High pressure flow probes shall be factory mounted in the low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing. Provide piezometer on each fan in an array. Transducer for measuring differential pressure shall be provided by the Temperature Control Contractor

(TCC). Include with fan submittal the empirically derived formulas developed by the fan manufacturer for each supply and return fan provided with the air handling unit, along with the recommended differential pressure transducer range.

F. Motors and Drives:

1. AC Induction Motors:
   a. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.
   b. Motor mounting bracket shall be adjustable to allow tightening of belts.
   c. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.
   d. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 0513.
   e. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
   f. No equipment shall be selected or operate above 90% of its motor nameplate rating.

G. Variable Frequency Drives:

1. Provided and installed by unit manufacturer. Refer to Section 26 2923 for requirements.

H. Coils:

1. Direct Expansion Coils:
   a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
   b. Galvanized steel casing.
   c. Suitable for 250 psig. Maximum air velocity of 500 fpm.
   d. AHRI rated for direct expansion use with R-410A.
   e. Size coils based on saturated suction temperature, EAT and cfm scheduled. The leaving DB and APD shall not exceed the scheduled values.
   f. Maximum 144 fins per foot. No water carryover shall occur at design airflow and no anti-carryover coating shall be used.
   g. All coils shall be split row or intertwined configuration.
   h. Minimum 0.016" tube wall thickness.
   i. Manufacturers:
      1) Trane
      2) York
      3) Heatcraft
      4) or Daikin

I. Burner and Heat Exchanger

1. Provide electronic modulating natural gas burner capable of modulating gas based on the turn down noted in the schedule. Provide dampers across burner sections to allow for the scheduled minimum air flow noted in drawing schedules. Dampers shall be controlled by burner controller based on modulating input signal for firing rate.
2. Gas Burner: Induced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shutoff, intermittent spark or glow ignition, flame sensing, and automatic 100 percent shutoff pilot.
3. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.

4. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.
5. Provide with 20 gauge, type 409, stainless steel, burners, flue collector, heat exchanger, and tubes on headers on all furnaces.

J. Filter Section:

1. Provide side-loading particulate pre-filter section located as scheduled on drawings. Filter module shall be equipped with framing for 2" deep MERV-8 pleated media filters and 12" deep cartridge filters. Provide pre-filter module with full height hinged access door.
2. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.
3. Reference Section 23 4000 for filter requirements.

K. Mixing and Filter Section:

1. Provide a combination mixing box and angle filter section. Damper arrangement shall be as shown on the drawings. Furnish dampers with the unit. Dampers shall be extruded aluminum with 6" airfoil blades, compressible metal jamb seals, molded synthetic or stainless steel sleeve bearings. The damper shall not leak more than 4 cfm/sq. ft. at 1" W.C. as tested per AMCA Standard 500-D-98. Maximum damper size shall be 48" in length. Provide multiple damper sections for larger lengths. Multiple dampers shall use individual actuators. Jackshafting is not acceptable. Maximum filter velocity shall not exceed specified value. Filters shall be as scheduled and have full size hinged access doors.
2. Provide an angle filter section for 2" thick filters. Maximum filter velocity shall not exceed specified value. Provide full size hinged access doors.
3. Reference Section 23 4000 for filter requirements.

L. Electrical Power:

1. Provide factory-mounted, vapor-tight light fixtures in each accessible section of the unit. The fixture shall be complete with junction box, globe, aluminum globe guard, switch, and bulb. Lighting shall be wired to a single 120-volt point, terminating at a designated junction box mounted on the air-handling unit. The Mechanical Contractor is responsible to complete all wiring connection between shipping splits after assembly.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements

1. Install per manufacturer's instructions.
2. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.
3. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.
4. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Coil Requirements:

1. Comb all coils to repair bent fins.
2. Extend coil drain and vent connections to outside unit housing. Provide normally closed valve on drain and vent connection outside of unit housing.

3.02 MANUFACTURER'S FIELD SERVICES

A. Provide factory authorized field representative for starting unit and training operator.

B. Prepare and start systems with installing contractor observation.

END OF SECTION

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SECTION 23 8200
TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Finned Tube Radiation.

B. Electric Wall Heaters.

C. Electric Unit Heaters.

1.02 QUALITY ASSURANCE

A. All filters shall be UL listed Class 1 or Class 2.

B. All electrical equipment shall have a UL label.

C. All louvers and dampers shall have AMCA certified ratings.

D. Factory wired equipment shall conform to ANSI/NFPA 70.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500.

B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.

C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.

D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.

E. Submit manufacturers' installation instructions.

F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.04 DELIVERY, STORAGE AND HANDLING

A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.05 REGULATORY REQUIREMENTS

A. Conform to ASHRAE 90.1.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

PART 2 - PRODUCTS

2.01 FINNED TUBE RADIATION - WALL HUNG

A. Cabinets shall be 12 gauge steel with baked enamel finish.

B. Final color selection shall be by the Architect.

C. Element hangers shall be quiet operating, cradle type.

D. Cabinet top shall be continuously supported on wall mounting strips. Lower front face of cabinet shall be secured to the enclosure brackets.

E. All cabinet and accessories shall be securely connected with no exposed fasteners.

F. Provide end caps, corner pieces, adjustable extensions, etc. as required for proper appearance and service.

G. Provide custom cabinet at corners where, in the Architect/Engineer's opinion, standard fittings will not fit correctly or have acceptable appearance. Custom cabinet shall be 14 gauge sheet metal with finish and shape to match manufacturer's cabinet. Submit drawings of each custom cabinet for approval.

H. Provide removable cabinet sections at all control valves. It shall not be necessary to remove several sections to maintain control valves.

I. Support 1/2" tubes on 36" centers and larger tubes on 48" centers.

J. Elements shall be copper tube with aluminum fins.

K. Cabinet size, element length, and element size shall meet the scheduled capacities, but not be less than the sizes scheduled.

L. Products:

1. Vulcan.
2. Sterling.
3. Zehnder-Rittling.
4. Shaw-Perkins.

2.02 ARCHITECTURAL ELECTRIC WALL HEATERS

A. Assembly: UL listed and labeled with terminal box and cover, fan guard, and built-in controls. Draw-through design. Provide with baked enamel finished steel back box suitable for wall mounting.

B. Heating Elements: Nickel-chromium resistance wire enclosed in a steel sheath with copper brazed plate fins.

C. Cabinet: Minimum 20 gauge steel with baked enamel finish. Provide surface mount, semi-recessed or fully recessed cabinet as called for on drawings.

D. Front Panel: Bar grille constructed of minimum 16 gauge cold-rolled steel, welded into a uniform grille and finished in baked enamel. Front grille shall have a satin finished aluminum frame around the periphery.

E. Fan: Direct drive propeller type, statically and dynamically balanced.

F. Motor: Permanently lubricated sleeve bearings, totally enclosed, automatic reset thermal overload protection.

G. Control: Unit-mounted tamper-proof thermostat, thermal cutout, double-pole single throw unit mounted disconnect covered by protective front panel.

H. Manufacturer:

1. Qmark Model AWH.
2. Markel Series 3400.
3. Berko Series FRC.
4. Redd-i.
5. Brasch.

2.03 ELECTRIC UNIT HEATERS

A. Horizontal or vertical discharge as scheduled on the drawings.

B. Horizontal units shall have adjustable outlet louvers.

C. Metal sheathed fin tube electric heating elements.

D. Casing: Heavy gauge steel with baked enamel finish.

E. Automatic reset thermal overload wired for instantaneous pilot operation of contactor holding coil.

F. Motors shall be totally enclosed continuous duty with built-in thermal overload protection.

G. Provide unit mounted and wired disconnect.

H. Provide resiliently mounted fan guard/motor support.

I. Fans: Direct drive propeller type, factory balanced.

J. Manufacturers:
1. Trane.
2. Chromalox.
3. Modine.
4. Reznor.
5. Berko.
6. Redd-i.
7. Brasch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:
1. Install all products per manufacturers' instructions.
2. Coordinate recess sizes for recessed equipment.
3. Protect units with protective covers during construction.
4. Comb all coils to repair bent fins.

B. Fin Tube:
1. Locate finned tube radiation as shown and run cover wall-to-wall, unless otherwise shown. Center elements under windows.

3.02 CLEANING

A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.

C. Install new filters.

END OF SECTION

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SECTION 26 0500
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 27 0528. This section is also applicable to Fire Alarm and Detection Systems Section 28 3100.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

1.03 SCOPE OF WORK

A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.

B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.

C. Separate contracts will be awarded for the following work.

D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

E. Description of Systems shall be as follows:

1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
3. Grounding system.
4. Fire alarm system.
5. Security system.
6. Wiring system for temperature control system as shown on the drawings.
7. Lightning protection system.
8. Wiring of equipment furnished by others.
9. Removal work and/or relocation and reuse of existing systems and equipment.
10. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.
11. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.

F. Work Not Included:

1. Telecommunications cabling will be by Division 27, in raceways and conduits furnished and installed as part of the Electrical work.
2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.04 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

B. Itemize all work and list associated hours and pay scale for each item.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, and CONTROL CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
    a. Luminaires.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical bus duct.
    d. Sheet metal.
    e. Cable trays, including access space.
    f. Other piping.
    g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    a. Scale of drawings:
        1) General plans: 1/4 Inch = 1 '-0" (minimum).

2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

b. Potential layout changes shall be made to avoid additional access panels.

c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa Codes, Laws, Ordinances and other regulations having jurisdiction.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
3. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
6. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.

E. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

F. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
26 05 73	Power System Study
26 09 13	Power Monitoring and Control System
26 09 33	Lighting Control System
26 22 00	Dry Type Transformers
26 24 16	Panelboards
26 24 19	Motor Control
26 27 26	Wiring Devices
26 28 13	Fuses
26 28 16	Disconnect Switches
26 28 21	Contactors
26 29 23	Variable Frequency Drives
26 32 13	Packaged Engine Generator Systems
26 36 00	Transfer Switch
26 41 00	Lightning Protection Equipment
26 43 00	Surge Protection Devices
26 51 19	LED Lighting
26 52 15	Emergency Lighting Inverter
28 31 00	Fire Alarm and Detection Systems
Drawings	Photocells, Timeclocks, Relays

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses

e. Supplier and manufacturer's names and addresses

f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)

g. Description of item submitted (using project nomenclature) and relevant specification number

h. Notations of deviations from the contract documents

i. Other pertinent data

j. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:
    a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
    b. The Contractor shall clearly indicate the size, finish, material, etc.
    c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
    d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 26 XX XX.description.YYYYMMDD
    b. Transmittal file name: 26 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
   a. Material: Delivered cost of product with taxes paid.
   b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
   a. Overhead and profit.
   b. Bonds.
   c. Insurance.
   d. General Requirements: Itemize all requirements.
4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
   a. Each piece of equipment requiring shop drawings. Use the equipment nomenclature (SB-1, PANEL P-1, etc.) on the Schedule of Values.
   b. Each type of small unitary equipment (e.g., FDS, FCS, CS, etc.). Multiple units of the same type can be listed together provided quantities are also listed so unit costs can be determined.
   c. Each conduit system (medium voltage, normal, emergency, low voltage systems, etc.). In addition, for larger projects breakdown the material and labor for each conduit system based on geography (building, floor, and/or wing).
   d. Fire alarm broken down into material and labor for the following:
      1) Engineering
      2) Controllers, devices, sensors, etc.
      3) Conduit
      4) Wiring
      5) Programming
      6) Commissioning
   e. Site utilities (5' beyond building)
   f. Seismic design
   g. Testing
   h. Commissioning
   i. Record drawings
   j. Punchlist and closeout

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.10 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.

B. Keep all materials clean, dry and free from damaging environments.

C. Coordinate the installation of heavy and large equipment with the trade contractors and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.14 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.

D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.

E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

1.16 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and 26 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS

2.01 GENERAL

A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:
1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:
1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:
1. Utilities Bedding: Lay underground utilities on minimum of 6"sand bedding CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope around utilities to 6" above utilities: Place and compact sand to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.

4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
6. Dispose of excess excavated earth as directed.
7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6-inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.03 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    a. All junction boxes are closed and identified in accordance with Section 26 0553 Electrical Identification.
    b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
    c. Luminaire whips are supported above the ceiling.
    d. Conduit identification is installed in accordance with Section 26 0553 Electrical Identification.
    e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
    f. All wall penetrations have been sealed.
2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

3.04 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.

C. The following must be submitted before Architect/Engineer recommends final payment:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
5. Inspection and testing report by the fire alarm system manufacturer.
6. Start-up reports on all equipment requiring a factory installation or start-up.

D. Circuit Directories:

1. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div26.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Maintenance of equipment.
2. Start-up procedures for all major equipment.
3. Description of emergency system operation.

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.

F. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.

G. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
2. If the Contractor does not have staff that can adequately provide the required instructions, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 RECORD DOCUMENTS

A. The following paragraphs supplement Division 1 requirements.

B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

F. Record actual routing of conduits exceeding 2 inches.

3.08 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.

B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.

C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.

D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect the color preference before ordering.

E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted; provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

F. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.

G. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.

H. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

3.09 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.

C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.

B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Raceway and Cable Routing Restrictions: Raceways and cable are restricted from being routed in the following locations, unless serving the space or permitted by the authority having jurisdiction.

1. Elevator machine rooms and hoistways.
2. Exit enclosures.
3. Other areas restricted by code.
4. Technology, data, server rooms.
5. Fire pump and sprinkler rooms.
6. Normal power in emergency power equipment rooms: Limited to feeders and branch circuits serving the emergency power equipment located in the room.
7. Emergency power in normal power equipment rooms: Limited to feeders and branch circuits serving the normal power equipment located in the room.

3.11 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Within the Limits of Construction:

1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.

2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.

B. Outside the Limits of Construction:

1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.
2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.
3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.

C. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. Trade contractors shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.
2. The Contractor shall continuously maintain the construction zone under a negative pressure of at least 0.01" w.g. minimum relative to all adjacent areas of the building.
    a. Exhaust fans used for this purpose shall filter air and discharge it outdoors or to the least populated area adjacent to the construction work using negative air machines designed specifically for this purpose. All filtration for air recirculated back into the building shall be HEPA (99.97% DOP efficiency) for work adjacent to healthcare or elderly facilities. If no work is adjacent to these areas, 95% filtration is acceptable. Filtering air discharged to outdoors shall be accomplished with 30% filters.
    b. If air is discharged outdoors, maintain all required distances to doors, windows, air intakes, etc.
    c. If high levels of Volatile Organic Compounds (VOC's) or odors are released, activated carbon or equivalent filtration shall also be employed. Exhaust shall not discharge near doors, air intakes, pedestrians, gathering areas, or operable windows.
    d. Adjusting existing air handling equipment to assist in pressure control is acceptable, if approved by the Owner and the authority having jurisdiction.
    e. Seal return, exhaust, and supply air openings in or near the construction zone that serve existing air handling systems, and rebalance the systems for proper operation. If this is impractical, add filters at the intakes of sufficient cross-sectional area to minimize the pressure drop and avoid the need for rebalancing.
    f. Maintain pressure control one hour before and after all construction periods, and 24 hours per day in healthcare or elderly facilities.
3. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
    a. Minimizing the amount of dust generated.
    b. Reducing solvent fumes and VOC emissions.
    c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
4. Request that the Owner designate an IAQ representative.
5. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.

6. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
7. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
8. Request copies of and follow all Owner's IAQ and infection control policies.
9. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
10. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
11. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings under Construction".

3.12 SYSTEM STARTING AND ADJUSTING

A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.

C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.13 FIELD QUALITY CONTROL

A. General:

1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.
3. If the ground resistance value obtained is more than the value set forth in Section 26 0526, the following shall be done to obtain the value given:
    a. Verify that all connections in the service ground system are secure.
    b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
    c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
    d. Review results with the Architect/Engineer.
4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:
    a. Date of test.
    b. Number of hours since the last rain.
    c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
    d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
    e. Make, model, and calibration date of test equipment.
    f. Tabulation of measurements taken and calculations made.

C. Ground-Fault Equipment Performance Testing:

1. Test: Perform ground-fault performance testing when system is installed. The test process shall use primary current injection per manufacturer instruction and procedures. Perform test for the following:
    a. Service disconnects
    b. Solid state molded case circuit breakers and solid-state insulated case circuit breakers equipped with ground fault protection.
    c. Fusible switches with ground fault relay protection.
    d. Outside branch circuits and feeders.
    e. Code required.
2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

D. Arc Energy Reduction Equipment Performance Testing:

1. Test: Perform arc energy protection performance testing when system is installed. The test process shall use primary current injection or approved method per manufacturer instructions and procedures. Perform test for the following:
    a. All arc energy reduction systems installed.
2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

E. Other Equipment:

1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.

F. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.

G. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.

H. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.

I. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

3.14 UTILITY REBATE

A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Smoke and fire/smoke dampers are wired and have been tested.
4. Per Section 26 0500, cable insulation test results have been submitted.
5. Per Section 26 0500, ground resistance test results have been submitted.
6. Operation and Maintenance manuals have been submitted as per Section 26 0500.
7. Bound copies of approved shop drawings have been submitted as per Section 26 0500.
8. Report of instruction of Owner's representative has been submitted as per Section 26 0500.
9. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
10. Start-up reports from factory representative have been submitted as per Section 26 0500.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

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SECTION 26 0505
ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.

B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.

C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.

E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.

F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.

G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

3.02 PREPARATION

A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.

B. Coordinate utility service outages with Utility Company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

D. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.

E. Existing Electrical Service: Maintain existing system in service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Service changeover shall be completed on an overtime basis.

F. Existing Fire Alarm System: Maintain existing system in service u. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Provide a watchman to make required premise observations during all outages, requirements as dictated by codes and Owner's insurance carrier.

G. Existing Telephone System: Maintain existing system in service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. System changeover shall be completed on an overtime basis.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.

D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

E. Disconnect and remove outlets and devices that are to be demolished. Remove outlet or devices' associated back box, supports, and conduit and conductors back to source. Patch opening created from removal of device to match surrounding finishes.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations under the Toxic Substance Control Act. Provide Owner and Architect/Engineer with a Certificate of Destruction to verify proper disposal.

I. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.

L. HID and fluorescent lamps, determined by the Toxicity Characteristic Leachate procedure (TCLP), to be hazardous waste shall be disposed of in an EPA-permitted hazardous waste disposal facility or by a permitted lamp recycler.

M. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

N. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Remove existing luminaires for cleaning as indicated on the drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, and broken electrical parts. Replacement parts shall match specified components for new luminaires of same type when applicable. Reinstall luminaire and connect to circuiting as indicated on drawings.

D. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.05 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

END OF SECTION

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SECTION 26 0513
WIRE AND CABLE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Building wire

B. Cabling for remote control, signal, and power limited circuits

C. Metal-clad cable (MC)

1.02 RELATED WORK

A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.03 REFERENCES

A. ASTM B801-07 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation

B. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy

C. NFPA 70 - National Electrical Code (NEC)

D. UL 44 - Thermoset-Insulated Wires and Cables

E. UL 83 - Thermoplastic-Insulated Wires and Cables

F. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords

G. UL 2196 - Fire Resistive, Fire Resistant and Circuit Integrity Cables

PART 2 - PRODUCTS

2.01 BUILDING WIRE

A. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.

B. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.

C. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.

D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.

E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.

F. Aluminum conductors are not to be used.

G. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.02 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.

1. Fire alarm
2. Low voltage switching and lighting control
3. Electronic control
4. Other specialized cabling, signal, and power limited cabling. Refer to the appropriate Division 23, 27, or 28 requirements; including, but not limited, to the following:
    a. Building Automation Systems and Controls, Division 23.
    b. Information Technology Backbone and Horizontal Cabling, Division 27.

c. Television Distribution Systems CATV, Division 27.

d. Sound Masking Paging Systems, Professional Audio/Video, Division 27.

e. Electronic Access Control, Intrusion Detection Systems, Video Surveillance, Division 28.

B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.

C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.03 METAL-CLAD CABLE (MC)

A. Conductors shall be copper, 600-volt insulation, THHN. Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Metal-Clad Cables, UL 15694, exterior of metal interlocked armor.

B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

C. Metal-clad cables may be used for branch circuit wiring as defined in the Electrical Code, subject to acceptance by State and local codes.

PART 3 - EXECUTION

3.01 WIRE AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings:

1. Building wire shall be installed in raceway.

2. Metal clad cable, Type MC, 1/2" size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires on non-essential circuits. The flexible whips shall be between 18" to 72" in length per Electrical Code.

B. All Other Locations: Building wire in raceway.

C. Above Grade: All conductors installed above grade shall be type "THHN".

D. Underground or In Slab: All conductors shall be type "THWN".

E. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.

F. Fire-Rated 2-Hour Feeders and Circuit Requiring Continuous Operation (CI): Refer to Part 2 of this section for acceptable products and assemblies. Installation shall meet UL 2196.

3.02 CONTRACTOR CHANGES

A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)). Conductors are based on copper conductor installed in underground electrical ducts.

B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.

C. Record drawing shall include the calculations and sketches.

3.03 GENERAL WIRING METHODS

A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.

B. Use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.

C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

D. Use no wire smaller than 8 AWG for outdoor lighting circuits.

E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

G. Splice only in junction or outlet boxes.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Make conductor lengths for parallel circuits equal.

J. All conductors shall be continuous in conduit from last outlet to their termination.

K. Terminate all spare conductors on terminal blocks, and label the spare conductors.

L. Cables or wires shall not be laid out on the ground before pulling.

M. Cables or wires shall not be dragged over earth or paving.

N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.

O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.

P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.04 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.

D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.

E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.

F. Only nylon rope shall be permitted to pull cables into conduit and ducts.

G. Completely and thoroughly swab raceway system before installing conductors.

H. Conductor Supports in Vertical Raceways:

1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.

2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.05 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Use suitable cable fittings and connectors.

C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when

shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.

D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.

E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.

G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.06 WIRING CONNECTIONS AND TERMINATIONS

A. Splice and tap only in accessible junction boxes.

B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.

C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.

D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.

F. Thoroughly clean wires before installing lugs and connectors.

G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.

I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:

1. Facing the front and operating side of the equipment, the phase identification shall be:
    a. Left to Right - A-B-C
    b. Top to Bottom - A-B-C

J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.07 MC CABLE INSTALLATION

A. AC/MC shall NOT be used for circuits serving the Essential Electrical System.

B. Cable shall be supported by an approved means every 4.5' and within 12" of outlet boxes, junction boxes, cabinets, or fittings.

C. Cable may be unsupported in the following conditions:

1. Cable is no longer than 2' in length at terminals where flexibility is necessary.
2. Cable is not more than 4.5' from the last point of support for connections within an accessible ceiling to light fixtures or equipment.

D. Conductor ampacity shall be derated as required by the Electrical Code where more than three current carrying conductors are used.

E. Each 120 and 277-volt circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for cable derating.

F. Cables shall be cut using a rotary cutter as recommended by the manufacturer to eliminate nicking and cutting of the conductors.

G. Bending radius shall comply with the requirements listed in the Electrical Code for the type and size of cable being installed, but shall not be less than 5-times the diameter of the cable in any case.

H. At cable terminations, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an insulating bushing or its equivalent protection shall be provided between the conductors and the armor.

I. All wiring devices supplied by nonmetallic-sheathed cables shall be mounted in an outlet box.

3.08 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.

C. Inspect wire and cable for physical damage and proper connection.

D. Torque test conductor connections and terminations to manufacturer's recommended values.

E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

F. Provide documentation of the manufacturer's recommended lug torque value for copper conductors, the date the lugs were torqued, and installed torque readings. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.

G. Protection of wire and cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.

H. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION

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SECTION 26 0526
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Equipment grounding system

B. Bonding system

C. Grounding electrode system

1.02 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with UL 467 Grounding and Bonding Equipment.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with Electrical Code; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

1.03 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

B. NFPA 99 - Standard for Healthcare Facilities

1.04 SUMMARY

A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

PART 2 - PRODUCTS

2.01 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section 26 0513 "Wire and Cable".

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated. Refer to Section 26 0553 for insulation color.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

G. Aluminum Bonding Conductors: As follows:

1. Bonding Cable: 10 strands of No. 14 AWG aluminum conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded aluminum conductor.

3. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.02 CONNECTOR PRODUCTS

A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Connectors: Hydraulic compression type, in kit form, and selected per manufacturer's written instructions.

C. Bolted Connectors: Bolted-pressure-type connectors.

D. Substation connectors shall comply with IEEE 837 listed for use for specific types, sizes, and combinations of conductors and connected items.

2.03 GROUNDING ELECTRODES

A. Ground Rods Copper-clad steel.

B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

C. Test Wells: Provide handholes as shown on drawings or as specified in Division 2 Section "Underground Ducts and Utility Structures."

D. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to Electrical Code, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet of 1/2"steel reinforcing bar.

PART 3 - EXECUTION

3.01 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.

G. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.

H. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.

I. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity. The connection to the non-metallic boxes shall be made to any metallic fitting or device requiring grounding.

J. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

K. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.02 INSTALLATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.

C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.

D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

E. In raceways, use insulated equipment grounding conductors.

F. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

G. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, below access floors, and elsewhere as indicated, with bolted connections to form a continuous ground path.

3.03 EQUIPMENT GROUNDING SYSTEM

A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.

B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by Electrical Code:

1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
2. Single-phase and three-phase motor and appliance branch circuits.
3. Flexible raceway runs, including FMC and LFMC.
4. Armored and metal-clad cable runs.

D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.04 BONDING SYSTEM

A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.

B. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.

C. Equipment Circuits: Install a bonding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, dampers, and heaters. Bond conductor to each unit and to air duct. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps or copper conductor sized equal to the equipment grounding conductor.

D. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.

E. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.

G. Telecom Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bar.

H. Terminal Cabinets: Terminate bonding conductor on cabinet grounding terminal.

I. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

J. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.05 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
4. Testing: Perform the following field quality-control testing:
    a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
    b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

1) Equipment Rated 500 kVA and Less: 10 ohms.

2) Equipment Rated 500 to 1000 kVA: 5 ohms.

3) Equipment Rated More Than 1000 kVA: 3 ohms.

4) Substations and Pad-Mounted Switching Equipment: 5 ohms.

5) Manhole Grounds: 10 ohms.

d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.06 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION

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SECTION 26 0527
SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Conduit and Equipment Supports

B. Fastening Hardware

C. Concrete Housekeeping Pads

D. Foundation and Underground Sleeves and Seals

1.02 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.03 COORDINATION

A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Allied Support Systems

B. Cooper B-Line

C. Erico, Inc.

D. Hilti

E. Power Fasteners

F. Orbit Industries

2.02 MATERIAL

A. Support Channel: stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.

B. Hardware: Corrosion resistant.

C. Anchorage and Structural Attachment Components:

1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
    a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
3. Welding Lugs: Comply with MSS-SP-69, Type 57.
4. Beam clamps for Steel Beams and Joists: Double sided or concentric open web joist hangars. Single-sided type is not acceptable.
5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural General Notes for lintel requirements in masonry construction.
3. Refer to Structural plans and specifications for lintel requirements and sizes.
4. Lintels:
   a. Lintels in non-bearing masonry wall openings can be sized in accordance with the note below. Lintels that occur in existing bearing walls are to be sized according to similar conditions and spans in the new construction and lintel schedule. Bottom plate size shall be a minimum of 3/8" thick. The width of the plate shall be 3/4" less than the field verified wall thickness. The plate shall be the full length of the lintel member. Lintels are not required over openings that are 12" wide or less and at least 1 course below the top of the wall.
   b. All lintels shall have a minimum of 8" end bearing.
   c. All lintels in exterior wall construction shall be hot-dip galvanized.
   d. For all openings not otherwise detailed or scheduled, minimum lintels shall be for each 4 inch of masonry width:
      1) 0 to 2'-0" span: 5/16" plate (3/4" less than wall width)
      2) 2'-0" to 4'-0" span: L 3 1/2 x 3 1/2 x 1/4
      3) 4'-0" to 6'-0" span: L4 x 3 1/2 x 5/16 (llv)
      4) 6'-0" to 8'-0" span: L5 x 3 1/2 x 5/16 (llv)
   e. All angles that are back to back shall be welded top and bottom 3" at 12" minimum.
5. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
6. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
7. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
8. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
9. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
10. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
11. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
12. Size sleeves large enough to allow expansion and contraction movement.

E. Concrete Housekeeping Pads:

1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.

2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.

F. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
4. Products:
   a. Anvil International HBS-Base Series
   b. Cooper B-Line Dura-Blok
   c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

G. Truss and Joist Support System: Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
   a. The hanger is attached within 6" from a web/chord joint.
   b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

2.03 FOUNDATION - UNDERGROUND SLEEVES AND SEALS

A. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, raceways passing through foundation walls to an underground condition shall have their annual space (sleeve or drilled hole “” not tapered hole made with knockout plug) sealed by properly sized sealing element consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve.
3. Sleeves shall be at least 2 trade sizes larger than the penetrating raceway.
4. Pressure shall be maintained by stainless steel bolts and accessories. Pressure plates may be of composite materials for Models S and OS.

5. Sealing Elements shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant / Stainless	Nitrile	-40°F to 210°F

6. Approved Manufacturers:
   a. Thunderline Corporation "Link-Seals"
   b. O-Z/Gedney Company
   c. Calpico, Inc
   d. Innerlynx

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.

B. Trapeze support installation: Cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

D. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.

E. Do not use powder-actuated anchors without specific permission.

F. Do not drill structural steel members.

G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.

I. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting.

J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

K. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

L. Refer to Section 26 0533 for special conduit supporting requirements.

3.02 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION

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SECTION 26 0533
CONDUIT AND BOXES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Rigid metallic conduit and fittings (RMC)
B. Electrical metallic tubing and fittings (EMT)
C. Flexible metallic conduit and fittings (FMC)
D. Liquidtight flexible metallic conduit and fittings (LFMC)
E. Rigid polyvinyl chloride conduit and fittings (PVC)
F. Wall and ceiling outlet boxes
G. Electrical connection
H. Pull and junction boxes
I. Accessories

1.02 RELATED WORK

A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.03 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
   2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
   3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
   4. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
   5. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
B. Federal Specifications (FS):
   1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
   2. A-A-55810 - Specification for Flexible Metal Conduit
C. NECA "Standards of Installation"
D. National Electrical Manufacturers Association (NEMA):
   1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
   2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
   3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
E. NFPA 70 - National Electrical Code (NEC)
F. Underwriters Laboratories (UL): Applicable Listings
   1. UL 1 - Flexible Metal Conduit
   2. UL 6 - Rigid Metal Conduit
   3. UL 360 - Liquid Tight Flexible Steel Conduit
   4. UL514-B - Conduit Tubing and Cable Fittings
   5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
   6. UL746A - Standard for Polymeric Materials - Short Term Property Evaluations
   7. UL797 - Electrical Metal Tubing

G. American Standard of Testing and Materials (ASTM):
1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material

H. Definitions:
1. Fittings: Conduit connection or coupling.
2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

PART 2 - PRODUCTS

2.01 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Manufacturers:
1. Allied
2. LTV
3. Steelduct
4. Calbond Calpipe
5. Wheatland Tube Co
6. O-Z Gedney
7. or approved equal.

B. Manufacturers of RMC Conduit Fittings:
1. Appleton Electric
2. O-Z/Gedney Co.
3. Electroline
4. Raco
5. Bridgeport
6. Midwest
7. Regal
8. Thomas & Betts
9. Crouse-Hinds

10. Killark
11. Orbit Industries
12. or approved equal.

C. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

D. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

E. PVC Externally Coated Conduit: Compliant with UL 6, ANSI C80.1 and NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. Threads shall be hot galvanized and coated with a clear coat of urethane. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system.

1. Acceptable Manufacturers:
    a. Calbond Calpipe
    b. Robroy
    c. T&B Ocal
    d. or approved equal.

2.02 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Manufacturers of EMT Conduit:

1. Allied
2. Calbond Calpipe
3. LTV
4. Steelduct
5. Wheatland Tube Co
6. or approved equal.

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.
2. 1/2" and 3/4" Conduit: Push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
3. Larger than 2": Compression type of steel designed for their specific application.
4. Manufacturers of EMT Conduit Fittings:
    a. Appleton Electric
    b. O-Z/Gedney Co.
    c. Electroline

d. Raco
e. Bridgeport
f. Midwest
g. Regal
h. Thomas & Betts
i. Orbit Industries
j. or approved equal.

2.03 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.

B. Manufacturers:
1. American Flex
2. Alflex
3. Electri-Flex Co
4. or approved equal.

C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

D. Fittings and Conduit Bodies:
1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
a. O-Z/Gedney Co.
b. Thomas & Betts
c. Appleton Electric
d. Electroline
e. Bridgeport
f. Midwest
g. Regal
h. Orbit Industries
i. or approved equal.

2.04 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Manufacturers:
1. Anaconda Type UA
2. Electri-Flex Type LA
3. Alflex
4. Carlon (Lamson & Sessions)
5. or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
    a. Appleton Electric
    b. O-Z/Gedney Co.
    c. Electroline
    d. Bridgeport
    e. Thomas & Betts
    f. Midwest
    g. Regal
    h. Carlon (Lamson & Sessions)
    i. Orbit Industries
    j. or approved equal.

2.05 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers:

1. Carlon (Lamson & Sessions) Type 40
2. Cantex, J.M. Mfg.
3. or approved equal.

C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.

D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.06 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.

B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.

C. Cast Boxes: Nema FB1, Type FD, Aluminum, cast feralloy, or stainless steel deep type, gasketed cover, threaded hubs.

D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.

F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.

G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.07 ECONN; ELECTRICAL CONNECTION

A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.08 JB; PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.

B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.

C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

E. Flanged type boxes shall be used where installed flush in wall.

PART 3 - EXECUTION

3.01 INSTALLATION TRAINING

A. PVC coated rigid metal conduit manufacturers shall provide Contractor installation training for field cutting, joint preparation, joint assembly, field bending, and field cut sealing.

3.02 CONDUIT INSTALLATION SCHEDULE AND SIZING

A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.

B. Installation Schedule: Refer to drawings.

C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

D. Minimum Conduit Size (Unless Noted Otherwise):

1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
2. Below Grade 5' or less from Building Foundation: 1 inch.
3. Below Grade More than 5' from Building Foundation: 1 inch.
4. Telecommunication Conduit: 1 inch.
5. Controls Conduit: 1/2 inch.

E. Conduit Embedded in Slabs above Grade:

1. Embedded installation NOT allowed in elevated slabs with metal composite decks nor structural pour in place slabs less than 6 inches in depth unless specifically noted or shown on drawings otherwise.
2. Maximum size 1-1/4 inch for conduits crossing each other.

F. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.03 CONDUIT ARRANGEMENT

A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.

B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.

C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):

1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3" concrete cover.
2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.

D. Conduit shall not share the same cell as structural reinforcement in masonry walls.

E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.

F. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.

G. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.04 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

1. Support wire used to independently support raceway and wiring systems above suspending ceilings shall be supported on both ends, minimum 12 gauge suspended ceiling support wire, and distinguishable from ceiling support systems by color (field paint), tagging, or equivalent means.

B. Conduit shall <u>not</u> be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.

F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.

G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.

L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:

1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.05 CONDUIT INSTALLATION

A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.

4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
    a. A third bend is acceptable if:
        1) The total run is not longer than (33) feet.
        2) The conduit size is increased to the next trade size.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:
1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. .
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system, equal to O-Z/Gedney type EYD.
9. Horizontal conduit routing through slabs above grade
    a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3" min. concrete cover. Conduits shall run parallel to each other and spaced at least 8" apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1".
    b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.
    c. No conduits are allowed to be routed horizontally through slabs above grade.
10. Do not route conduits across each other in slabs on grade.

11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.
17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

3.06 CONDUIT TERMINATIONS

A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.

B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.

F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.

G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.07 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.

2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f'c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

F. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with "JackMoon" or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).
3. Duct Seal Alternative Option: Inflatable duct seal system. Capable of withstanding a 10-foot head of water (5 PSEI).
    a. Manufacturers:
        1) Raychem Rayflate Duct Sealing Systems RDSS
        2) Approved equal

3.08 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
3. Direct contact with concrete except slab on grade.
4. Recessed in stud wall of kitchens and laundries.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Hazardous locations.
3. Exposed interior locations within 8' of the highest platform level.
4. Direct contact with earth.
5. Direct contact with concrete in slab on grade.
6. Wet locations.
7. Kitchens and laundries when exposed on wall surface.

3.09 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer.

D. Locate and install to maintain headroom and to present a neat appearance.

E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.10 OUTLET BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)

D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.

E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.

F. Provide knockout closures for unused openings.

G. Support boxes independently of conduit.

H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.

K. Position outlets to locate luminaires as shown on reflected ceiling drawings.

L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.11 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

B. Support pull and junction boxes independent of conduit.

C. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.

2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.12 EXPOSED BOX INSTALLATION

A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.

B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.

C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.

D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.

E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)

F. Wood, plastic, or fiber plugs shall not be used for fastenings.

G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION

SECTION 26 0553
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Adhesive Markings and Field Labels

B. Nameplates and Signs

C. Product Colors

1.02 REFERENCES

A. NFPA 70E - National Electrical Safety Code

B. NFPA 70 - National Electrical Code (NEC)

C. ANSI A13.1 - Standard for Pipe Identification

D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

PART 2 - PRODUCTS

2.01 ADHESIVE MARKINGS AND FIELD LABELS

A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).

1. Label Size as follows:

a. Raceways: Kroy or Brother labels 1-inch high by 12-inches long (minimum).

2. Color: As specified for various systems.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40°F to 185°F (-40°C to 85°C), type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.

F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.

G. Aluminum, Wraparound Marker Bands: 1-inch width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

H. Brass or Aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch metal tags with stamped legend, punched for fastener.

I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

J. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.

a. Font: Normal 721 Swiss Bold

b. Adhesive Labels: 3/16 inch minimum text height

c. Vinyl / Plastic Laminate Labels: 3/4" inch minimum text height

2.02 NAMEPLATES AND SIGNS

A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.

B. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
    a. Text Height: 3/8 inch minimum

C. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting ¼" grommets in corners.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.

E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.03 PRODUCT COLORS

A. Adhesive Markings and Field Labels:

1. All Labels: Black letters on white face
2. Normal Power and General Labels: Black letters on white face
3. Control Labels: Black letters on white face
4. Fire Alarm: Red letters on white face
5. Emergency: Red letters on white face

B. Nameplates and Signs:

1. NORMAL POWER: Black letters on white face
2. Control Labels: Black letters on white face
3. EMERGENCY: White letters on red face
4. GROUNDING: White letters on green face.
5. CAUTION or UPS: Black letters on yellow face

C. Raceways and Conduit:

1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
    a. Normal Power and General Distribution: Silver
    b. Emergency Power Distribution System:
        1) Optional Standby: Orange
        2) Life Safety and Critical Branch: Yellow
        3) Equipment Branch: Orange
    c. Fire Alarm System: Red
    d. Temperature Controls: Refer to mechanical cover sheet for color
    e. Ground: Green

D. Box Covers:

1. Box cover colors shall match conduit colors listed above.

E. Conductor Color Identification: Refer to Part 3 for additional information.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.

B. Exposed Ceilings and Finished Spaces: The project includes exposed ceilings in finished spaces. The installation of colored raceways and labeling may not be aesthetically desirable in finished spaces. The contractor shall coordinate identification requirements in exposed ceilings of finished spaces with the A/E prior to installation and ordering of materials.

C. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

E. Circuit Identification: Tag or label conductors as follows:

1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

F. Apply warning, caution and instruction signs as follows:

1. Install warning, caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

G. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.

H. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

I. Install ARC FLASH WARNING signs on all power distribution equipment per Section 26 0573.

! WARNING
ARC FLASH AND SHOCK HAZARD
APPROPRIATE PPE REQUIRED
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY
REFER TO NFPA 70E

J. Circuits with more than 600V: Identify raceway and cable with "DANGER-HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot intervals.

1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to conduits concealed within wall.
3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Selective Coordination Label: Install caution signs on all switchboards, distribution panels, panelboards, disconnects, and other equipment with selectively coordinated overcurrent protection devices. Sign at a minimum shall contain:

1. CAUTION: OVERCURRENT DEVICES IN THIS ENCLOSURE ARE SELECTIVELY COORDINATED. EQUIVALENT REPLACEMENTS AND TRIP SETTINGS ARE REQUIRED.

L. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.02 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

C. Identification material to be engraved plastic-laminated labels, 1/16-inch minimum thickness with white letters on a red face. Letter and number size to 1/8-inch high.

D. Identification to be engraved directly on the stainless steel coverplates. Letter and number size to 1/8-inch high.

E. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24"). Identification for switch cover plates shall be installed on the inside cover.

3.03 CONDUIT AND EXPOSED CABLE LABELING

A. Product:

1. Adhesive labels and field markings

B. Conduit Identification: Pre-printed, flexible, self-adhesive vinyl labels with legend at 20 foot (6 meter) intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible, or separated by enclosures, walls, partitions, ceilings, and floors. Labels for multiple conduits shall be aligned. Refer to color requirements in Part 2 when applicable in addition to the following:

1. 1000 Volt or less Normal/Emergency Power: Indicate feeder identification and voltage.
2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
3. Fire Alarm: Indicate "FIRE ALARM".
4. Grounding: Indicate "GROUND" and equipment and designation.
5. Security System: Indicate "Security".
6. Telephone System: Indicate "Telephone".

C. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

3.04 BOX LABELING

A. Products:

1. Adhesive labels and field markings

B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape OR Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

C. All junction, pull, and connection boxes shall be identified as follows:

1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
3. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

3.05 CONDUCTOR COLOR CODING

A. Products:

1. All wire and cables shall be color coded by the manufacturer.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.

D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

E. Conductors shall be color coded as follows:

1. 208Y/120 Volt, 4-Wire:
   a. A-Phase - Black
   b. B-Phase - Red
   c. C-Phase - Blue
   d. Neutral - White
   e. Ground Bond - Green
2. 480Y/277 Volt, 4-Wire:
   a. A-Phase - Brown
   b. B-Phase - Orange
   c. C-Phase - Yellow
   d. Neutral - Gray
   e. Ground Bond - Green
3. Grounding Conductors:
   a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
4. Cabling for Remote Control, Signal, and Power Limited Circuits:
   a. Fire Alarm: Red.
   b. Low Voltage Switching: Per manufacturer recommendations and code requirements.

c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.

d. Electronic Control: Per manufacturer recommendations and code requirements.

e. Structured Cabling: Refer to Division 27.

3.06 CONTROL EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served.
2. Location of equipment being served if it is not located within sight.
3. Voltage and phase of circuit(s).
4. Panel and circuit number(s) serving the equipment.
5. Method of automatic control, if included ("AUTO CONTROL BY FMCS").
6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
7. Date of fault current study, refer to one-line diagram
8. Sample Label:
   EXHAUST FAN EF-1 ("LOCATED ON ROOF")
   480V, 3-PHASE
   FED FROM "1HA1-1"
   AUTO CONTROL BY FMCS
   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.07 EQUIPMENT CONNECTION IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner. The following list of equipment is specifically being listed to receive an equipment connection label; this list does not limit the equipment that shall receive a label:

1. Mechanical heating, ventilation, and air conditioning equipment; chillers, boilers, pumps, air handing ventilation units, condensing units, unit heaters, and similar equipment
2. Plumbing equipment
3. Fire protection equipment including fire pumps
4. Kitchen equipment (hardwired)

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served
2. Location of equipment being served if it is not located within sight.
3. Voltage and rating of the equipment.
4. Panel and circuit numbers(s) serving the equipment
5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.

6. Date of fault current study; refer to one-line diagram
7. Sample Label:

   UNIT HEATER UH-1 ("LOCATED IN STORAGE ROOM 200")
   480V: 3-PHASE
   FED FROM "1HA1-1"
   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.08 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Products:
   1. Nameplates and signs

B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.
   1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
   2. Exterior Equipment: The identification material shall be engraved vinyl labels.
   3. Labeling shall include:
      a. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Applicable equipment includes components of the life safety and critical branch for healthcare facilities (generators, transfer switches, switchboards, distribution panels, panelboards, etc.).
      b. Equipment type and contract documents designation of equipment.
      c. Voltage of the equipment.
      d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
      e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
      f. Sample Label:

         DISTRIBUTION PANEL DP-H1
         480Y/277V
         FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)
   4. Provide the following on a separate label, installed below the label above:
      a. Available fault current; refer to one-line diagram or panel schedules
      b. Date of fault current study; refer to one-line diagram
      c. Sample Label:

         22,000 AMPS AVAILABLE FAULT CURRENT
         DATE OF STUDY: 1 JAN 2017

C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:
   1. Nominal system voltage, service wire size, quantity, material, distance
   2. Maximum available fault current; refer to one-line diagram for values
   3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 26 0573 for value.
   4. Date of fault current study; refer to one-line diagram
   5. Date of label

6. Sample Label:

   480Y/277V, 6 SETS 4#750KCM CU, 75FT
   39,800 AMPS AVAILABLE FAULT CURRENT
   0.07 SECOND CLEARING TIME
   DATE OF STUDY: 1 JAN 2017
   DATE OF LABEL: 4 JUL 2017

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.
   a. Label: "This equipment is designed with a system listed below".
   b. Applicable Systems:
      1) Zone-selective interlocking system for selective coordination and arc energy reduction
      2) Differential relaying system for selective coordination and arc energy reduction
      3) Arc energy reducing maintenance switch
      4) Energy reducing active arc flash mitigation system

E. Adjustable-Trip Over Current Protection Label:

1. Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with adjustable trip settings. Provide label separate from load identification label.
   a. Label:
      1) Long-time delay:
      2) Long-time pickup:
      3) Short-time delay:
      4) Short-time pickup:
      5) Instantaneous:
      6) Ground fault delay:
      7) Ground fault:
   b. Sample Label:

Long-time delay:	10.0
Long-time pickup:	1.0
Short-time delay:	0.15
Short-time pickup:	5.0
Instantaneous:	2.0
Ground fault delay:	0.25
Ground fault:	50.0

F. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

G. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with feeder wire size, feeder wire quantity, conductor material and distance in feet. Provide label separate from load identification label and adjustable trip settings label.

1. Sample Labels for Feeders:

   4#3/0 CU & 1#6 CU GND, 125FT
   4#250KCM AL & 1#6 GND CU, 125FT
   2 SETS 4#400KCM CU & 1#1 GND CU, 125FT

H. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 0500 for other requirements.

3.09 TRANSFORMER EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.

C. Labeling shall include:

1. Equipment type and contract documents designation of equipment
2. Name of the upstream equipment.
3. Voltage and rating of the equipment.
4. Location of the upstream equipment if it is not located within sight.
5. Sample Label:

   TRANSFORMER TR-15
   480V: 208Y/120V 15KVA
   FED FROM SWITCHBOARD "SB-1" (LOCATED IN ELEC 123)

3.10 ELECTRICAL WORKING CLEARANCE IDENTIFICATION

A. Products:

1. Safety Yellow paint and custom stencils

B. Provide custom identification of electrical equipment working clearances in mechanical, electrical, storage, janitorial, and similar non-public areas.

C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch wide stripes.

1. Width of area: Width of equipment or as required by code
2. Depth of area: Depth as required by code

END OF SECTION

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SECTION 26 0573
POWER SYSTEM STUDY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Low voltage distribution system power study.

B. Short-circuit analysis and report.

C. Selective coordination analysis and report.

D. Arc-flash hazard analysis and report.

1.02 RELATED SECTIONS

A. Section 26 0500 - Basic Electrical Requirements

B. Section 26 2413 - Switchboards

C. Section 26 2416 - Panelboards

D. Section 26 3213 - Packaged Engine Generator Systems

E. Section 26 3600 - Transfer Switch

1.03 QUALITY ASSURANCE

A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections.

1.04 SUBMITTALS

A. Documentation shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.

B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths and field investigation of existing equipment types, sizes, ratings provided by the Electrical Contractor. IMEG will provide a preliminary Power Tools for Windows project file for information, if requested.

C. Documentation of the analyses shall be submitted in a single bound electronic (PDF or equal) format and shall accompany the shop drawing submittals for equipment provided under the related work specification sections. The submittal of these related specification sections will not be reviewed without this documentation. Submit a sample arc-flash hazard label for Owner review and approval prior to printing.

D. Power system study project model shall be submitted on electronic media for review and the Owner's operating and maintenance records.

1.05 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

B. NFPA 70E - Standard for Electrical Safety in the Workplace

C. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations, latest version

D. ANSI Z535.4 - Products Safety Signs and Labels

1.06 SCOPE

A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.

B. Contractor is required to provide a fully coordinated system for the normal and essential emergency electrical system or essential emergency electrical system and the associated normal side of each transfer switch and all other locations indicated on the one line diagram. Contractor shall provide overcurrent protective devices with the appropriate models, frame sizes, trip units, etc. as required to provide a selectively coordinated system.

PART 2 - PRODUCTS

2.01 Power systems study shall be completed in Power Tools for Windows (PTW) 8.0 or later version or pre-approved equivalent program.

PART 3 - EXECUTION

3.01 SHORT-CIRCUIT ANALYSIS

A. Provide a complete short-circuit analysis from the utility service to and including the entire building distribution as shown on the drawings.

B. Analysis shall include the entire distribution system from the point of connection to the utility power source to the distribution panels and branch circuit panelboards.

C. Short-circuit analysis documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted and made available to the AHJ if requested.

3.02 SELECTIVE COORDINATION ANALYSIS

A. Provide a complete selective coordination analysis comparing time/current curves of the protective devices to be installed to assure coordination between main and downstream devices. Overcurrent protection devices shall be coordinated based on the maximum available fault current results of the short-circuit analysis report.

B. Provide a complete selective coordination analysis, comparing time/current curves of the protective devices to be installed to assure complete selectivity between main and downstream devices for code-required branches and branches identified on one-line drawings. Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01 second. Overcurrent protective devices serving the normal shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01.

C. Provide trip settings for all (selectively coordinated and non-selectively coordinated) adjustable trip over current protection devices including long time delay, long time pickup, short time delay, short time pickup, instantaneous and ground fault. Selectively coordinated branches shall be based on the selective coordination study results. Non-selective coordinated branches shall be based on the design trip ratings. Provide selective coordination between all ground fault trip settings.

D. The analysis shall include primary protective device, secondary main switchboard device(s), switchboard branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.

E. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.

1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.
2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.
3. Each primary protective device required for the transformer shall be selected so the characteristics or operating band is within the transformer parameters, which shall include a parameter equivalent to 58% of the withstand point to afford protection for secondary line-to-ground faults. The transformer damage curve shall be included for the transformer when the selected protective device is not within the associated parameters.
4. Molded case circuit breakers shall be separated from each other and the associated primary protective device by a 16% current margin for coordination and protection in the event of secondary line-to-line faults.

5. Include zone selective interlocking, differential relaying, and other selective coordination technology in the study when required by other specification sections.
6. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.
7. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.
    a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.

F. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.

3.03 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.

C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit analysis and coordination study models. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
    1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.
    2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

H. Include Arc Energy Reduction (AER) analysis in the study when required by other specification sections.

I. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.

J. Miscoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.

M. Labels shall be vinyl or laminated, with a self-adhesive backing, conform with ANSI Z535.4 Products Safety Signs and Labels standard, and include the following:

1. Arc flash boundary
2. Available incident energy calculated in the analysis and the corresponding working distance, or the arc flash personal protective equipment (PPE category) for the equipment, but not both.

N. Examples showing the minimum required information follow:

O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

3.04 ADJUSTMENTS

A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study. Apply settings prior to placing equipment into operation. When the scope of work or execution includes remodel or phases construction, the contractor shall adjust applicable settings as required prior to each system component placed in operation.

B. Wherever the arc flash incident energy exceeds Arc Flash Category 2 (i.e. greater than 8 cal/cm^2), provide options for adjusting breaker trip times, if possible, to reduce energies to Category 2 or below.

3.05 TRAINING

A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

END OF SECTION

SECTION 26 0800
ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Provider (CxP) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The electrical equipment and systems to be commissioned, including commissioning activities for the following specific items:
   1. Automatic Transfer Switch
   2. Packaged Engine Generator
   3. Lighting Controls
   4. Fire Alarm Monitoring
   5. Variable frequency drives.
   6. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.

B. Section 017900 - Demonstration and Training: Scope and procedures for Owner personnel training.

C. Section 019113 – General Commissioning Requirements

D. Section 26 0933 – Lighting Control Systems.

E. Section 26 3213 – Packaged Engine Generator Systems.

F. Section 26 3600 – Transfer Switch.

1.03 REFERENCE STANDARDS

A. ASHRAE Guideline 0-2013 – The Commissioning Process.

B. ASHRAE Standard 202-2018 - Commissioning Process for Buildings and Systems.

1.04 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Provider informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. Draft Prefunctional Checklists and Functional Test Procedures: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
   1. System name.
   2. List of devices.
   3. Step-by-step procedures for testing equipment or system.
   4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to

specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.

5. Description of the instrumentation required for testing.

C. Startup Reports: Submit for approval of Commissioning Provider.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 GENERAL

A. Cloud based software will be utilized for maintaining Prefunctional Checklists, Functional Performance Testing and Issue management. Contractors will be required to utilize the system. Logins will be provided to the contractors, and the software does not require a subscription fee from the contractors.

3.02 PREPARATION

A. Cooperate with the Commissioning Provider in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Provider.

C. Coordinate with the Owner, GC / CM and all other trade contractors for testing of generator and transfer switches. Engage equipment supplier, vendor or start-up technicians for support during loss of power testing. Trade contractor shall also coordinate with the electric utility company if it is deemed necessary to fully disconnect from the utility power source to test the generator and transfer switch. Trade Contractor(s) shall provide necessary field technicians to troubleshoot and adjust items on site during generator and transfer switch testing.

D. If load bank testing of generators, UPS or inverter systems will be utilized, notify Commissioning Provider no less than 96 hours in advance or testing.

3.03 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Provider for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.04 FUNCTIONAL TESTING

A. Prefunctional Checklists for equipment, system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.

C. Using a skilled technician who is familiar with this equipment or system, execute the Functional Testing of the equipment or system as required by the Commissioning Provider.

D. If the equipment or system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 DEMONSTRATION AND TRAINING

A. See Section 01 7900 for additional requirements.

B. Demonstrate operation and maintenance of the systems or equipment to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Provider during Functional Testing.

D. Provide the services of manufacturer representatives to assist instructors where necessary.

END OF SECTION

SECTION 26 0913
POWER MONITORING AND CONTROL SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Power monitoring and control system is defined to include, but is not limited to, remote devices for monitoring and communication interface hardware.

1.02 RELATED SECTIONS AND WORK

A. Refer to the One-Line Diagram for rating, location and configuration.

1.03 REFERENCES

A. ANSI C12 - Code for Electrical Metering

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Provide product data showing the type, size, rating, catalog number, manufacturer's names, and/or data sheets for all items to ensure compliance with these specifications. Submit operation and programming manual.

C. Submit shop drawings of the complete layout of the entire system, showing wiring and all equipment.

1.05 REGULATORY REQUIREMENTS

A. System: UL listed.

1.06 SYSTEM DESCRIPTION

A. The power monitoring and controls (PMCS) shall consist of electronic power monitoring devices as designated on the project drawings and described herein. The system shall be capable of monitoring, displaying, logging, and communicating the true RMS measurements in this specification as a minimum level of performance. The system shall be designed so the maximum response time from an event or reading to displaying shall be 10 seconds.

B. Minimum accuracy of readings shall be:

1. Frequency ± 0.01 Hz.
2. Current and voltage ± 0.5% of reading.
3. Energy ± 1% of reading.

1.07 PROJECT RECORD DOCUMENTS

A. Provide installation and maintenance manuals under provisions of Section 26 0500. Include name, address and telephone number of service location within 100 miles of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Square D - POWERLOGIC and ION Enterprise

B. Eaton Power Xpert

C. ABB

D. Siemens

2.02 POWER MONITORING DEVICES INSTALLATION

A. All metering devices, electronic trip units shall be installed by the equipment manufacturer for all circuits as indicated by the project drawings.

B. All control power, CT, PT, and data communications wire shall be factory wired and harnessed within the equipment enclosure. Where external circuit connections are required, terminal blocks shall be provided, and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type to be used.

C. Provide control transformers, current transformers, and fused potential transformers sized as required.

2.03 POWER MONITORING DEVICE CHARACTERISTICS

A. DPM; Power Meter:

1. The following instantaneous readings shall be monitored, displayed, by the power meter:
    a. Frequency, monthly maximum and minimum
    b. Current, per phase RMS, 3-phase average RMS, apparent RMS, peak demand (15-minute sliding window)
    c. Voltage, phase-to-phase and phase-to-neutral
    d. Power factor, per phase and 3-phase total
    e. Real power (kW), 3-phase total, peak demand, cumulative (kWH)
    f. Reactive power (kVAR), 3-phase total
    g. Total harmonic distortion (current and voltage)
2. The current and voltage signals shall be digitally sampled at a rate high enough to provide true-RMS sensing through the 31st harmonic. All setup parameters required by the power meter shall be stored in nonvolatile memory and retained in the event of a control power interruption. The meter shall maintain, in nonvolatile memory, maximum and minimum values for each of the instantaneous values reported, as well as the time and date of the highest peak for all peak demand readings.
3. The power meter shall be equipped with a display to provide local access to all metered quantities.
4. Reset of the following electrical parameters shall also be allowed from the front of the display or energy meter:
    a. Peak demand current
    b. Peak demand power
    c. Energy (MWH)
    d. Reactive energy (MVARH)
5. Waveform Capture Capability: Waveform capture shall be for three (3) cycles and initiated manually using software.
6. The data points shall be sampled in a manner that allows the original power signals with proper magnitude and phase relationships to be reconstructed. Reconstruction of the original power signal from the stored data points shall have sufficient accuracy to allow steady-state power harmonic analysis that provides valid information on harmonic content for up to the 81st harmonic of the fundamental power frequency.
7. The power meter shall have one (1) digital input and one (1) digital solid state output/KY pulse output.
8. The power meter shall be provided with a six (6) digital input and two (2) digital output (relay) output accessory card.
9. Manufacturers:
    a. Square D Power Logic PM820
    b. Eaton
    c. Siemens PAC4200
    d. ABB M4M Series

B. Electronic Trip Units:

1. Electronic trip units shall be provided as designated on the project drawings.

2. They shall provide the following breaker/trip unit information to the PMCS network:
   a. Breaker sensor rating
   b. Rating plug
   c. Date/time of last trip
   d. Type of last trip (overload, short circuit, ground fault)
   e. Magnitude of phase and ground fault at time of last trip
   f. Number of overload trips
   g. Number of short circuit trips
   h. Number of ground fault trips
3. The electronic trip units designated P in the one-line diagram shall provide equivalent information to the digital power meter specified above. The electronic trip units designated H in the one-line diagram shall provide equivalent information to the power quality meter specified above.

2.04 SYSTEM DISPLAY UNITS

A. System display units shall be provided to display the data available from selected electronic trip units connected on the individual data transfer network.

B. The system display unit shall utilize a 4 line by 20 character, high contrast display with backlighting. The level of backlighting as well as the contrast shall be adjustable.

C. The system display shall be equipped with a screen saver feature to extend the life of the display.

D. Data shall be displayed in a logically organized manner, complete with the proper scaling and units.

E. The system display unit shall allow for easy operation by providing a keypad with large keys for operator selections. The keys shall have a raised perimeter and tactile feedback to provide a positive response, even with gloved-hand operation.

F. The keys shall be clearly marked to indicate the function and separated into meaningful groups, with display prompting to assist the user in operation.

G. Each system display unit shall be configured by the manufacturer with all necessary data. It shall be possible to change the configuration for each system display unit using the keypad provided on each display. Access to configuration functions shall be password protected to prevent unauthorized or accidental modification.

H. The system display unit shall permit the reset of the stored min-max values in the power monitoring devices. It shall also permit the reset of the accumulated energy values and the time and date stamps stored in the metering devices. These resets shall be limited to authorized persons by means of password protection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type to be used.

B. All wiring required to externally connect equipment lineups shall be installed by the Electrical Contractor.

3.02 STARTUP AND TRAINING

A. The power monitoring manufacturer shall provide a full-time telephone technical help center for customers.

END OF SECTION

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SECTION 26 0933
LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Line and low voltage standalone lighting controls

1.02 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 51 19 LED Lighting
2. 26 52 15 Emergency Lighting Inverter
3. Electrical Drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.03 RELATED WORK

A. Section 01 9100 - Commissioning

B. Section 23 0900 - Facility Management Control System (FMCS)

C. Section 26 5100 - Lighting

1.04 QUALITY ASSURANCE

A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required.

B. All components and assemblies are to be factory pre-tested prior to delivery and installation.

C. Comply with Electrical Code as applicable to electrical wiring work.

D. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

E. Panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Panels and accessories used for control of life safety and critical branch circuits shall be listed under UL 924 Emergency Lighting and Power Equipment.

F. All assemblies are to be in compliance with FCC emissions standards specified in Part 15 Subpart J for Class A applications.

1.05 REFERENCES

A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

B. FS W S 896 Switch, Toggle

C. International Energy Conservation Code (IECC)

D. NEMA WD 1 - General Color Requirements for Wiring Devices

E. NEMA WD 7 - Occupancy Motion Sensors

F. NFPA 70 - National Electrical Code (NEC)

G. UL Standard 916 Energy Management Equipment

H. UL 924 - Emergency Lighting and Power Equipment

I. UL 1472 - Solid-State Dimming Controls

1.06 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements, and roles and responsibilities of all persons and groups involved in installation, execution, and commissioning.

C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

D. Submit a list of devices and equipment that will be installed for each sequence of operation.

E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, occupancy sensors, control stations, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.

F. Verify acceptance of communications connection to building automation system. Submit BACnet IP parameters.

1.07 EXTRA STOCK

A. Provide extra stock under provisions of Section 26 0500.

B. Sensors, Controls, Power Supplies, and Relays: Five (5) percent of quantity installed. Minimum of two (2) of each configuration and type.

C. Relays and Dimmer Modules: Five (5) percent of quantity installed. Minimum of two (2) of each size and type.

D. Control Stations: One (1) of each configuration and type, except for LCD touch screens requiring factory setup prior to installation.

1.08 PROJECT RECORD DOCUMENTS

A. Submit project record documents under provisions of Section 26 0500.

B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit emergency, operation, and maintenance data under provisions of Section 26 0500. Data shall also include the following:

1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
3. Replacement part numbers for all system components.

B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.

C. Submit software operating and maintenance manuals, program software backup on compact disc or compatible media with data files, device address list, and a printout of software application and graphic screens, where applicable.

1.10 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system (LCS). These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.

B. Provide an integrated lighting controls system consisting of panels, power supplies, controllers, sensors, relays, switches, devices, wiring, etc. necessary to perform the Lighting Control Sequence of Operation as defined on the plans and specifications. Contractor is responsible for confirming that all components and luminaires interoperate as a single system.

1. Sequence of Operation: Describes the required operation and performance for lighting control in each space. Sequences of operation are indicated on the drawings.
2. Drawings: The drawings include sequences of operation, locations of control interface devices, sensors, and control zones. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted with the shop drawings.

C. The following control types and features are acceptable. Acceptable control locations are shown on the drawings.

1. Line Voltage Control: Control equipment consists of traditional line voltage wiring devices and equipment such as switches, dimmers and combination occupancy/vacancy sensor switches, etc.
2. Distributed Control: Control equipment is in the space/zone being controlled; not reliant on centralized controllers.
    a. All locations shall have the ability to be networked for remote control and monitoring.
3. Centralized Control: Control equipment is in a central location serving multiple spaces/zones and provides time-based schedule and remote control.
    a. The lighting control system (LCS) shall be networked with BACnet IP capabilities.
    b. The lighting control system (LCS) shall have DMX512 capabilities.
4. Wireless Control: Equipment that uses radio frequency to transmit lighting control signals.

1.11 COMMISSIONING

A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 1 for detailed commissioning requirements.

B. The Contractor shall provide all services necessary for compliance with the IECC Section C408 Commissioning. The commissioning shall include, but not be limited to, a commissioning plan, preliminary commissioning report, construction documents, manuals, final commissioning report, and lighting system functional testing.

C. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning. The commissioning process, equipment, and systems to be commissioned are defined in Division 1.

D. The Contractor shall notify the Commissioning Agent, Architect/Engineer and Owner's Representative ten (10) working days prior to scheduled commissioning date.

E. The commissioning process requires meeting attendance. Refer to Division 1 for meeting requirements.

F. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

1.12 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.

B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LIGHTING CONTROLS

A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications. Lighting control switches, systems, and components shall be listed.

B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.

C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.

2.02 DEVICE COLOR

A. All switch, lighting controls, and coverplate colors shall be the same as wiring devices, unless indicated otherwise.

2.03 COVERPLATES

A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 0553.

D. Plate-securing screws shall be metal with head color matching the wall plate finish.

2.04 WALL SWITCHES

A. Refer to Electrical Symbols List for device type.

B. Switch touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi. Coverplate color shall match the switch color.

1. Manufacturers:
    a. Cooper 7621 CuVerro
    b. Leviton A5621
2. Install antimicrobial switches and cover plates in following departments:
    a. ICU, NICU, OR, Cath Lab

C. SW-1P; Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
2. Manufacturers:
    a. Hubbell HBL1221
    b. Leviton 1221-2
    c. Pass & Seymour PS20AC1
    d. Cooper AH1221
3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:
    a. Hubbell DS120
    b. Leviton 5621

c. Pass & Seymour 2621
d. Cooper 7601.

D. SW-3W; Three-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:
a. Hubbell 1223
b. Leviton 1223-2
c. Pass & Seymour PS20AC3
d. Cooper AH1223
3. 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:
a. Hubbell DS320
b. Leviton 5623
c. Pass & Seymour 2623
d. Cooper 7623

2.05 WALL DIMMERS

A. UL listed with integral air-gap switch for on/off control.
B. Integral EMI/RFI suppression.
C. Non-viewable heat sink.
D. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.
E. Dimmer to match device color.
F. SW-D-LED; LED Electronic Driver Dimmer:
1. 277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60629 Annex E.
2. Manufacturers:
a. Compatible with provided LED driver.
G. SW-D3-LED; LED Electronic Driver Three-Way Dimmer:
1. 277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60929 Annex E.
2. Manufacturers:
a. Compatible with provided LED driver.

2.06 LOCAL DAYLIGHTING CONTROLS

A. SW-LS-PC; Standalone Exterior Photo Sensors:
1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.
2. Sensor shall contain an integral switching contactor rated for 277-volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero-crossing closure to provide 100,000 cycle minimum operation.
3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.

4. Sensor shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:
    a. Ambient sensitivity range of 5 to 1,500 foot-candles.
    b. Adjustable setpoint.
    c. Deadband adjustment by percentage of setpoint.
    d. Time delay of up to five minutes.
5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.
6. Manufacturers:
    a. Paragon
    b. Tork
    c. Intermatic

2.07 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Vacancy sensors require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by Electrical Code.
4. Mounting:
    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
    c. Time Delay and Sensitivity Adjustments: Recessed and concealed.
5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Power Supply and Child Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
10. Warranty: Five (5) year warranty.

B. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic or acoustic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. SW-OC-D; 360 Degree Coverage Pattern:
    a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay, integrated isolated relay contact. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: ambient sensor 40 FC.

b. Manufacturers:
1) Watt Stopper DT 300 Series
2) Hubbell OMNI-DT2000 or ATD2000C
3) Greengate OAC-DT
4) Leviton OSC##-MOW
5) Sensor Switch CM PDT 10

2. SW-OC-D-W; Wall Mounted on Adjustable Swivel Mount:
a. Wall or ceiling sensor with adjustable settings to allow manual on/auto off or auto on/auto off. Integrated ambient light level sensor (2 to 100 FC range).
b. Manufacturers:
1) Watt Stopper DT-200 Series
2) Hubbell LODTRP
3) Leviton OSM12--M series
4) Sensor Switch WvPDT 16 Series

3. Sensitivity Adjustment: Separate for each sensing technology.
4. Detection Coverage:
a. Task Areas: Detect occupancy anywhere in an area based on hand motion.
b. Circulation Areas: Detect occupancy anywhere in an area based upon half-step walking motion.

C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.
D. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.
1. SW-O; Wall Switch Occupancy Sensor:
a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (10 to 150 FC range), adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes, ambient sensor 40 FC.
b. Manufacturers:
1) Watt Stopper PW-100 Series
2) Sensor Switch WSX
3) Hubbell LHIRS1 or AP1277
4) Leviton ODS15
5) Greengate OSW-P-0451

2. SW-OC-P-P; Ceiling Mounted - 360 Degree Coverage Pattern:
a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
b. Manufacturers:
1) Watt Stopper CI Series
2) Sensor Switch CM-9
3) Hubbell Automation Omni-IR
4) Leviton OSC Series
5) Greengate OMR-P Series

3. With daylight filter and lens to afford coverage applicable to space to be controlled.

E. Ultrasonic Type: Ceiling mounting. Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. SW-OC-U; 360 Degree 20' x 20' Hand Motion Coverage Pattern:
    a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated 1-amp relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
    b. Manufacturers:
        1) Watt Stopper WT-1100 series
        2) Hubbell OMNI-US or ATU series
        3) Leviton OSC series
        4) Greengate ODC-U series
2. SW-OC-U-A; 360 Degree Two-Sided Corridor Coverage Pattern:
    a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
    b. Manufacturers:
        1) Watt Stopper WT-2250 Series
        2) Hubbell OMNI-US or ATU series
        3) Greengate ODC-U Series
3. Crystal controlled with circuitry that causes no detection interference between adjacent sensors.

2.08 DISTRIBUTED LIGHTING CONTROL

A. Manufacturers: as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. Acuity Controls nLight Series
2. Legrand Watt Stopper DLM Series
3. Hubbell Automation NX Series
4. Eaton Greengate RC3 Series (room-based system)
5. Osram Encelium Series
6. Lutron

B. System Description: The lighting control system shall be a network of remote modules. System includes all associated wiring, relay modules, photocells, switches, dimmers, time clock, occupancy sensors. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.

C. Control Devices: All occupancy sensors (ultrasonic, IR and dual technology type), photocells, switches, and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

D. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277-volt wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to four (4) relays. Relay modules shall be labeled with room number that relays control lighting within.

E. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, 50,000 cycles at rated capacity.

F. Network Hub: Network Hub shall contain processor and astronomic time clock for control and monitoring of lighting. Network hub shall be fed from an equipment emergency circuit at a minimum.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION MEETING

A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control centralized, wireless, and distributed systems.

3.02 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings.

B. All wiring shall be installed in conduit. Class II low voltage control wiring may be open wiring and shall maintain 150 mm (6 inch) spacing from electronic ballast and other RFI/EMI sources.

C. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

3.04 SUPPORT SERVICES

A. System Startup:

1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.

B. Testing:

1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.

2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming, However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:

   a. Confirm occupancy sensor placement, sensitivity, and time delay settings to meet specified performance criteria.

   b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.

   c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.

3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.

4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.
    a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
    b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.

C. Training:
1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.
2. Training duration shall be no less than three (3) days, with one (1) day being scheduled at least two (2) weeks after initial training.

D. Documentation:
1. Manufacturer shall provide system documentation including:
    a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or BMS/BAS interface unit.
    b. Drawings for each panel showing hardware configuration and numbering.
    c. Panel wiring schedules.
    d. Typical diagrams for each component.

3.05 SYSTEM COMMISSIONING

A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 0900, General Commissioning, for further details.

B. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 0900, General Commissioning, for system verification tests and commissioning requirements.

C. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 0900, General Commissioning, for Contractor training requirements.

END OF SECTION

SECTION 26 2200
DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Dry type two winding transformers (TR-#)

1.02 REFERENCES

A. NEMA - ST 1 - Specialty Transformers

B. NEMA ST 20 - Dry Type Transformers for General Applications

C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers

D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers

E. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.

F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

1.03 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 26 0500.

B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.

C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.01 DRY TYPE TWO WINDING TRANSFORMERS

A. Acceptable Manufacturers:

1. Square D 7400 EX##T / SK300##KB Series
2. Eaton V48M / H48M / B48M Series
3. ABB 9T Series
4. Hammond SG / SMK Series
5. Siemens 3F3 Series

B. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

C. Insulation system and average winding temperature rise for rated KVA as follows:

D. Case temperature shall not exceed 40°C rise above ambient at its warmest point.

E. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

F. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.

G. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
Equivalent Winding kVA Range	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

I. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

J. Coil Conductors: Continuous windings with terminations brazed or welded.

K. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.

L. Isolate core and coil from enclosure using vibration-absorbing mounts.

M. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount transformers on four 3”x3”x1/2” thick, 50 durometer rubber vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Ventilated transformers: Provide factory label on horizontal surface to prohibit storage on top, front, or adjacent to transformer.

3.02 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Service and distribution panelboards: DP-#

B. Lighting and appliance branch circuit panelboards: Panel '###'

1.02 RELATED SECTIONS AND WORK

A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

1.03 REFERENCES

A. NEMA AB 1 - Molded Case Circuit Breakers

B. NEMA KS 1 - Enclosed Switches

C. NEMA PB 1 - Panelboards

D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

E. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment

F. UL 67 - Panelboards

1.04 SUBMITTALS

A. Submit shop drawings for equipment and component devices under provisions of Section 26 0500.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.

E. Submit manufacturer's instructions under provisions of Section 26 0500.

1.05 SPARE PARTS

A. Keys: Furnish four (4) each to the Owner.

PART 2 - PRODUCTS

2.01 RATINGS

A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 0553 for additional requirements.

2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.02 MAIN AND DISTRIBUTION PANELBOARDS

A. General

1. Manufacturers:

a. Square D QMB, I-Line

b. ABB ReliaGear Entelleon

c. Siemens F2, P4

d. Eaton PRL4, PRL5

B. Panelboards: NEMA PB 1; type as shown on the drawings.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with concealed trim clamps and hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.

G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.

H. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

I. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

J. Arc Energy Reduction:

1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.

2.03 BRANCH CIRCUIT PANELBOARDS

A. General

1. Manufacturers:

a. Square D NQ, NF

b. ABB A Series

c. Siemens P1

d. Eaton PRL1, PRL2

B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.

J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.

B. Height: 6 feet to handle of highest device.

C. Provide filler plates for unused spaces in panelboards.

D. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.

3.02 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION

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SECTION 26 2419
MOTOR CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Manual motor starters

B. Magnetic motor starters

C. Combination magnetic motor starters

1.02 RELATED SECTIONS AND WORK

A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

1.03 REFERENCES

A. ANSI/UL Standard 508. Standard for Industrial Control Equipment

B. FCC Rules and Regulations, Part 15, Subpart J- Radio Frequency Interference

C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service

D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)

E. FS W-P-115 - Power Distribution Panel

F. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted

G. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters

H. NEMA AB 1 - Molded Case Circuit Breakers

I. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies

J. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

K. NEMA KS 1 - Enclosed Switches

L. NEMA PB 1 - Panelboards

M. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.

D. Submit manufacturer's instructions under provisions of Section 26 0500.

1.05 SPARE PARTS

A. Keys: Furnish four (4) each to the Owner.

B. Fuses: Furnish three (3) spare fuses of each type and rating installed to the Owner.

C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 0500.

B. Deliver in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.

C. Store and protect products under provisions of Section 26 0500.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.

E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.01 MANUAL MOTOR STARTERS

A. Acceptable Manufacturers:

1. Square D 2500 Series
2. Eaton MS Series
3. ABB
4. Siemens SMF/MMS Series

B. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.

C. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.

D. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.

E. Enclosure: NEMA ICS 6; Type 1.

2.02 MAGNETIC MOTOR STARTERS

A. Acceptable Manufacturers:

1. Square D
2. Eaton
3. ABB
4. Siemens
5. Franklin Control

B. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

C. Full Voltage Starting: Non-reversing type, unless otherwise indicated.

D. Reduced Voltage Starting: Closed-circuit transition wye-delta type: NEMA ICS 2, closed transition with adjustable time delay.

E. Two Speed Starting: Two speed, one winding, variable torque type. NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.

F. Coil Operating Voltage: 120 volts, 60 Hertz, obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating, and control devices, plus 100% spare capacity.

G. Size: NEMA ICS 2; size as shown on the drawings.

H. Overload Relay:

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

I. Enclosure: NEMA ICS 6; Type 1.

J. Combination Motor Starters: Combine motor starters with disconnect switch in common enclosure. Provide with disconnecting means as indicated on drawings.

K. Auxiliary Contacts: NEMA ICS 2; two normally open, field convertible contacts in addition to seal-in contact.

L. Pushbuttons: NEMA ICS 2; START/STOP in front cover.

M. Elapsed Time Meters: Heavy duty with readout in tenths of an hour.

N. Indicating Lights: NEMA ICS 2; RUN: red in front cover.

O. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.

P. Relays: NEMA ICS 2.

Q. Control Power Transformers: 120 volt fused secondary, fused primary, minimum VA as scheduled:

1. Size 1 - 100 VA
2. Size 2 - 100 VA
3. Size 3 - 150 VA
4. Size 4 - 300 VA
5. Size 5 - 300 VA
6. Size 6 - 300 VA

R. Provide phase loss protection relay with contacts to de-energize the starter for each starter serving motors 5 HP or greater.

2.03 CONTROLLER OVER-CURRENT PROTECTION AND DISCONNECTING MEANS

A. Acceptable Manufacturers:

1. Starter manufacturer

B. Molded Case Thermal-Magnetic Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole. NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

C. Non-fusible Switch Assemblies: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Provide with Class 'R' rejection clips. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install motor control equipment in accordance with manufacturer's instructions on concrete bases.

B. Install fuses in fusible switches.

C. Select and install heater elements in motor starters to match installed motor characteristics.

D. Set field-adjustable switches and circuit-breaker trip ranges.

E. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

END OF SECTION

SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Device plates and box covers

B. Receptacles (REC-#)

C. Cord and plug sets

1.02 RELATED SECTIONS

A. Section 26 0538 - Underfloor Ducts.

1.03 QUALITY ASSURANCE

A. Provide similar devices from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Electrical Code, by a testing agency to Authorities Having Jurisdiction and marked for intended use.

C. Comply with the Electrical Code.

1.04 REFERENCES

A. DSCC W-C-896F - General Specification for Electrical Power Connector

B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet

C. NEMA WD 1 - General Color Requirements for Wiring Devices

D. NEMA WD 6 - Wiring Devices - Dimensional Requirements

E. NFPA 70 - National Electrical Code (NEC)

F. UL 498 - Standard for Attachment Plugs and Receptacles

G. UL 943 - Standard for Ground Fault Circuit Interrupters

1.05 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

C. Provide a non-returnable sample of each countertop and furniture-mounted receptacle assembly as part of the submittal process.

1.06 COORDINATION

A. Receptacles for Owner Furnished Equipment: Match plug configurations.

B. Cord and Plug Sets: Match equipment requirements.

C. Coordinate installation of receptacle assemblies in countertops and furniture with the Contractor providing the countertop or furniture. Contractor shall coordinate penetrations and conduit routing in countertops and furniture with drawings and other obstacles below the installation surface.

PART 2 - PRODUCTS

2.01 DEVICE COLOR

A. All switch, receptacle, and outlet colors shall be verified with Architect, unless indicated otherwise.

2.02 COVERPLATES

A. All switches, receptacles, and outlets shall be complete with the following:

1. #302 stainless steel coverplates in finished spaces where walls are finished.
2. #302 stainless steel coverplates in unfinished spaces for flush boxes.
3. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 0553.

D. Plate securing screws shall be metal with head color matching the wall plate finish.

2.03 RECEPTACLES

A. Refer to Electrical Symbols List for device type.

B. Devices that are shaded on the drawings shall be red.

C. Devices that are shaded on the drawings shall be red and shall have an illuminated face or indicator light to indicate that there is power to the device.

D. REC-DUP: NEMA 5-20R Duplex Receptacle:

1. Heavy Duty: 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap with integral ground contacts.
    a. Manufacturers:
        1) Hubbell 5362
        2) Leviton 5362
        3) Pass & Seymour 5362A
        4) Cooper AH5362

E. REC-DUP-GFI: NEMA 5-20R Ground Fault Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
    a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
    b. Manufacturers:
        1) Hubbell GFCI type devices are not allowed. Contractor may substitute an alternative manufacturer when Hubbell is the basis of submittal for all other wiring devices.
        2) Leviton GFNT2
        3) Pass & Seymour 2097
        4) Cooper SGF20

F. REC-DUP-WP: NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, weather resistant WR listed. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
    a. Manufacturers:
        1) Hubbell:
            a) GFTWRST20 with aluminum housing WP826
            b) GFCI type devices are not allowed. Contractor may substitute an alternative manufacturer when Hubbell is the basis of submittal for all other wiring devices.
        2) Leviton GFWT2 with aluminum housing M5979
        3) Pass & Seymour 2097TRWR with aluminum housing WIUCAST1
        4) Cooper WRSGF20 with aluminum housing WIUMV-1

G. REC-SIM-520R: NEMA 5-20R Simplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
    a. Manufacturers:
        1) Hubbell HBL5361
        2) Leviton 5361

3) Pass & Seymour 5361
4) Cooper 5361

H. REC-SIM-530R: NEMA 5-30R Simplex Receptacle:
1. 125-volt, 30 amp, 3-wire grounding type, phenolic face.
a. Manufacturers:
1) Hubbell HBL9308
2) Leviton 5371
3) Pass & Seymour 3802
4) Cooper 5716N

I. REC-SIM-620R: NEMA 6-20R Simplex Receptacle:
1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
a. Manufacturers:
1) Hubbell HBL5461
2) Leviton 5461
3) Pass & Seymour 5871
4) Cooper 5461

J. REC-SIM-1530R: NEMA 15-30R Simplex Receptacle:
1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
a. Manufacturers:
1) Hubbell HBL8430A
2) Leviton 8430
3) Pass & Seymour 5740
4) Cooper 8430N

K. REC-SIM-L520R: NEMA L5-20R Simplex Receptacle, Locking Type:
1. 125-volt, 20 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.
a. Manufacturers:
1) Hubbell
2) Leviton
3) Pass & Seymour L520
4) Cooper CWL520R

L. REC-QUAD: NEMA 5-20R Double Duplex Receptacle:
1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
a. Manufacturers:
1) Refer to Duplex Receptacle above.

M. REC-QUAD-GFI: NEMA 5-20R Double Duplex GFI Receptacle:
1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.
a. Manufacturers:
1) Refer to Duplex GFI Receptacle above.

N. REC-QUAD-WP: NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:
   1. Consists of two duplex, GFI receptacles. Double gang box. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
      a. Manufacturers:
         1) Receptacle: Refer to GFCI Receptacle above.
         2) Cover:
            a) Intermatic WP1030MXD
            b) Pass & Seymour WIUCAST2
            c) Thomas & Betts Red Dot 2CKU

O. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

P. Side wired devices shall have four binding screws that are undercut for positive wire retention.

Q. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

2.04 FLOOR BOXES

A. Cover Color and Style: Verify with Architect from manufacturer standard options.

B. Refer to Technology drawings for voice/data, Audio/Video outlet, and coordination requirements.

C. Floor Boxes Housing Material Based on Cast-in-Place Floor Type:
   1. Slab on Grade: Cast Iron or listed for slab on grade with special kit, coating ,or equivalent; corrosion resistant.

D. FB-1: Round Flush with Finished Floor:
   1. Floor Box, round, round flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with4-inch minimum concrete pour floors, fully adjustable.
   2. Gang / Outlet Descriptions:
      a. Power furniture/equipment feed with flexible whip and 1-inch conduit.
   3. Manufacturers:
      a. Cast:
         1) Hubbell 2503 Series
         2) Legrand Wiremold 880 Series
         3) ABB Steel City 600 Series
   4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Provide hub reducers when applicable.

2.05 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.

B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.

C. Ground Fault Protection: Provide ground fault protection for all branch circuit breakers serving 120/208 receptacle outlets rated 21 - 50 amps single phase and 21-100 amps three phase in the following locations, as shown on drawings, or required by adopted code:

1. Bathrooms, locker rooms, shower rooms
2. Kitchens
3. Rooftops
4. Interior/Exterior locations subject to damp/wet conditions
5. When located within 6 feet of sinks, bathtubs, and shower stalls

D. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.

E. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

F. Install devices and wall plates flush and level.

G. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 0553 - Electrical Identification.

H. Test receptacles for proper polarity, ground continuity and compliance with requirements.

I. Floor Box Installation:

1. Set boxes level and flush with finish flooring material.
2. Use cast iron floor boxes for installations in slab on grade. Trim shall match floor covering to be used.
3. Provide a minimum horizontal offset of 24 inches between boxes.
4. Provide saw-cutting and patching of existing concrete floors as necessary for floor box installations within existing floors.

END OF SECTION

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SECTION 26 2813
FUSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fuses

1.02 REFERENCES

A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types

B. UL 198E - Class R Fuses

C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)

D. NEMA FU 1 - Low Voltage Cartridge Fuses

E. NFPA 70 - National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

1.04 EXTRA MATERIALS

A. Provide three of each size and type of fuse installed.

1.05 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40°F or more than 100°F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS - FUSES

A. Bussman, Division of Eaton

B. Edison Fuse, Division of Cooper Industries

C. Mersen

D. Littelfuse Inc

2.02 FUSES

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.

D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.

E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.

F. Control transformer fuses: Class CC (time delay).

G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install fuses where indicated on the drawings and specifications.

B. Install fuses in accordance with manufacturer's instruction.

C. Install fuses in packaged equipment as required by equipment manufacturer.

D. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

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SECTION 26 2816
DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fusible switches

B. Non-fusible switches

C. Enclosures

1.02 RELATED SECTIONS AND WORK

A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.03 REFERENCES

A. NEMA KS 1 - Enclosed Switches

1.04 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.

C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.05 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Acceptable Manufacturers:

1. Square D 3110 Series
2. Eaton DH Series
3. ABB TH Series
4. Siemens HNF / HF Series

B. FDS-#; Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.

C. DS-#; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. Enclosures: Type as indicated on the disconnect schedule.

E. Accessories: As indicated on the disconnect schedule.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.02 ADJUSTING

A. Set field-adjustable circuit breaker trip ranges.

END OF SECTION

SECTION 26 2923
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable frequency drives (VFD-#)

1.02 RELATED SECTIONS AND WORK

A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

B. Divisions 21, 22, 23 - Fire Protection, Plumbing, and Mechanical when referenced.

1.03 REFERENCES

A. ANSI/UL Standard 508

B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems

C. IEEE Standard 519-2014 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters

D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

C. Product Data: Provide catalog sheets showing PWM configuration (6, 12, 18 pulse, Active Front End AFE), voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

D. Product Data for Accessories and Options: Provide catalog sheets showing voltage, dimensions, ratings, for accessories and options. Include information for passive harmonic filters, active harmonic filters, line reactors, shielded VFD cabling, output filters, etc. as an inclusive submittal package provided by the VFD supplier. The VFD supplier shall act as a single contact of responsibility.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

F. Contractor's Letter of Acknowledgement: The contractor shall include a letter acknowledging the following with date and signature. The letter shall include a location for the installing contractor to sign the document:

1. The manufacturer/vendor received a complete copy of the design document specifications, plans, and schedules as related to the variable frequency drive requirements for the project.
2. The contractor and manufacturer have reviewed the distance relationship between the VFD location and the motor(s) served in conjunction with the installing contractors cable routing plan. The submittal includes compliance with the minimum requirements for each specific application including the addition of harmonic filters and shielded VFD cabling. The contractor is responsible for compiling and documenting information including cable lengths for mutual review with the manufacturer.
3. Leading Power Factor Management: The manufacturer has reviewed the design and identified VFD applications scheduled to operate on a generator power source.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 26 0500.

B. Accept controllers on site in original packing. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

D. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    a. Each installed unit's type and details.
    b. Nameplate legends.
    c. Short-circuit current rating of integrated unit.
    d. UL listing for series rating of overcurrent protective devices in combination controllers.
    e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

E. Manufacturer Seismic Qualification Certification: Submit certification that VFDs, accessories, and components will withstand seismic forces defined in Division 26 Section 26 0548 "Seismic Requirements for Equipment and Supports". Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Variable Torque Applications:

1. Toshiba Q9 Series
2. ABB ACH 580 (HVAC) / ACS 580 (other applications) Series
3. Allen Bradley PowerFlex Series
4. Danfoss VLTFC100 Series
5. Mitsubishi FR-F800 Series
6. Square D, S-Flex / ATV660 Series
7. Eaton MMX / HMX / SVX Series
8. Yaskawa Z1000 Series

B. Constant Torque Applications:
   1. Toshiba G9 Series
   2. ABB ACS 580 / 880 Series
   3. Allen Bradley PowerFlex Series
   4. Danfoss VLT5000 Series
   5. Mitsubishi FR-A800 Series
   6. Square D ATV960 Series
   7. Eaton SVX Series
   8. Yaskawa A1000 Series

C. The Variable Frequency Drive Schedule and drawings use equipment tags to define the scope of the project. The equipment tag (example: VFD-5) may be representative of multiple similar applications. Additional options and accessories may be required by the specifications and manufacturer recommendations due to the specific application but not represented in the Variable Frequency Drive Schedule. Refer to the Options, Accessories, and minimum performance requirements of this specification for a complete list of requirements (example: output filters and shielded VFD cables).

D. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule and Mechanical Schedules when applicable.

2.02 MINIMUM PERFORMANCE, REQUIRED OPTIONS, AND ACCESSORIES

A. The following minimum performance requirements, options, and accessories supplement the requirements of the Variable Frequency Drive Schedule. In the event of a conflict between the schedule and specification the most stringent requirement will be enforced.
   1. Manual Speed Adjustment
   2. Electronic Thermal Overloads
   3. Control Transformer, Fused, 120 volt. Acceptable Alternative, 120 volt / 24 volt power supply available directly from VFD, 100mA minimum.
   4. Hand-off-Auto Door Switch
   5. Skip Frequency Capability

B. Line Input Reactor: Provide all VFDs with a minimum input line reactor of (3%). The input line reactor may be integral or individually mounted.
   1. Exception: The manufacturer may substitute an LCL type harmonic filter with an input harmonic filter; an approximate equivalent (3%) impedance from the harmonic filter is anticipated.
   2. Exception: A dual (positive and negative) 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter. Exception: Not required for Active Front End AFE drives with an IGBT front end instead of a diode-bridge configuration.

C. Forced Ventilation Accessories and Operation: Provide per manufacturer requirements as required for the standard performance of the drive, the application, and environmental conditions.
   1. Provide inlet air outlet filter when a fan is provided. Provide an outlet filter if appropriate for the physical construction of the VFD.
   2. Field replaceable blower fan sized to maintain VFD at rated operating temperatures for ambient conditions of enclosure location. The VFD manufacturer's air change requirements shall be satisfied or exceeded for enclosed applications.

D. Harmonic Distortion Performance Criteria (PCC defined at VFD): The variable frequency drive shall have the following minimum harmonic distortion performance criteria; reference to the latest edition of IEEE 519. The Point of Common Coupling PCC shall be considered the input line terminals of the combination VFD, applicable filters, and accessories for the following requirements.

1. The minimum configuration represents the minimum acceptable solution to achieve THDv and TDDi performance requirements. Alternative approved solutions have been listed and shall be substituted within the scope of the original bid pricing when the minimum configuration does not satisfy the harmonic performance requirements listed.
2. Equivalent HP rating: When a single VFD is configured to serve multiple smaller motors (example: skid packaged equipment, fan wall systems) the equivalent sum of the motor HPs (VFD HP rating) shall be considered the HP rating for the following criteria.
3. VFD rating 15 HP or less:
    a. Minimum Configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
        1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent
        2) Current Total Demand Distortion (TDDi) limit: 5 percent
    b. Approved Solutions for Minimum THDv and TDDi Performance: The following approved solutions or a combination of the following is acceptable:
        1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.
        2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
        3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.
4. VFD rating exceeding 15HP to 99HP:
    a. Minimum configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
    b. Minimum Performance Criteria:
        1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent
        2) Current Total Demand Distortion (TDDi) limit: 5 percent
    c. Approved solutions for minimum THDv and TDDi performance: The following approved solutions or a combination of the following is acceptable:
        1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.
        2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
        3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.
5. VFD rating 100HP or larger:
    a. Minimum configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
    b. Minimum Performance Criteria:
        1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent
        2) Current Total Demand Distortion (TDDi) limit: 5 percent

3) IEEE 519 compliance at the drive/filter input terminals with a voltage imbalance or 3% or larger, operation at unity power factor, and dynamic braking to prevent regeneration to the supply.

c. Approved solutions for minimum THDv and TDDi performance: The following approved solutions or a combination of the following is acceptable:

1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.

2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.

3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.

E. Harmonic Distortion Performance Criteria (PCC defined at utility): The variable frequency drive shall have the following minimum harmonic distortion performance criteria, reference to the latest edition of IEEE 519.

1. The minimum configuration represents the minimum acceptable solution to achieve THDv and TDDi performance requirements. Alternative approved solutions have been listed and shall be substituted within the scope of the original bid pricing when the minimum configuration does not satisfy the harmonic performance requirements listed.

2. Equivalent HP rating: When a single VFD is configured to serve multiple smaller motors (example: skid packaged equipment, fan wall systems) the equivalent sum of the motor HPs (VFD HP rating) shall be considered the HP rating for the following criteria.

3. Harmonic Distortion Compliance Method:

a. Minimum Configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.

b. Minimum Performance Criteria: IEEE 519 latest edition compliance at the utility service Point of Common Coupling PCC. The THD shall not exceed IEEE 519 nor the following criteria, whichever is more stringent.

1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent

2) Current Total Demand Distortion (TDDi) limit: 5 percent

3) Perform harmonic system analysis prior to bid. Include additional input line reactors, filters, etc. for IEEE 519 compliance with bid. Refer to Approved Solutions for minimum THDv and TDDi performance below.

c. Approved solutions for minimum THDv and TDDi performance: The following approved solutions or a combination of the following is acceptable in lieu of the minimum configuration for compliance with IEEE 519:

1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.

2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.

3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.

F. Existing Conditions - Performance Verification: The scope includes the addition of an existing facility.

1. Measure Pre-existing Conditions: The contractor shall use a power quality meter to measure the pre-existing THDv and TDDi conditions of the facility at the electrical service entrance. The measurement shall be performed prior to any new equipment being installed. Include results of measurements with submittals: Include the following results:

2. Measure Installed Conditions: The contractor shall use a power quality meter to measure the post-installation THDv and TDDi conditions of the facility at the electrical service entrance. The measurement study may be performed during building commissioning, . Submit with O&M documents.
3. Include the following data for each test:
    a. THDv (voltage)
    b. TDDi (current)
    c. Power Factor
    d. Maximum Demand Current IL (Amps)
4. The minimum power metering duration per test shall be: 2 days.

G. VFD Output Load Terminals - Minimum Design Requirements:
1. Provide external output line reactors, DV/DT, sine filters, and shielded VFD cable when the manufacturer™™s recommended maximum distance between the VFD and the motor(s) is exceeded.
2. Provide the following minimum design criteria in addition to manufacturer recommendations:
    a. Output line reactor (3 percent): When recommended by manufacturer.
    b. DV/DT output line reactor: VFD to motor distance exceeds 75 feet (480 volt) or 150 feet (240/208 volt).
    c. Sine Wave Output Line Reactor: VFD to motor distance exceeds 150 feet (480 Volt) or 280 feet (240/208 Volt).
    d. Shielded VFD Motor Cable: Horsepower ratings exceeds 100 HP for any cable length.

H. Leading Power Factor Management: The project includes a packaged engine emergency generator. VFD applications including a capacitor solution (example: Harmonic Filters) shall include provisions to disconnect or step control the capacitor components when the associated motor load is not operating to prevent a leading power factor while operating on the generator power source.

2.03 VFD DESCRIPTION, RATINGS, DESIGN

A. Pulse Width Modulated (PWM) Variable Frequency Drives:
1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC motors. The controller shall be suitable for use with standard inverter duty motors without requiring any modifications to the motor or the drive.
2. Drives shall be capable of use with commercially available Internal Permanent Magnet (IPM) motors up to 12 poles.
3. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz.
    a. 50HP applications and less: If derating of the inverter is necessary to run at 8kHz, then the unit™™s derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.

B. Active Front End (AFE) Variable Frequency Drives:
1. Active Frond End (AFE) variable frequency drive with an Insulated Gate Bipolar Transistor (IGBT) based front end and LCL filter to mitigate switching noise. The AFE shall allow for regenerative power flow unless associated with a distribution system using a packaged engine generator.

C. Short Circuit Current Rating SCCR Default: 100 KA. Provide integral circuit breaker or fuse switch with disconnect switch when required to achieve rating.

D. Drive and controller shall be capable of continuous full load operations throughout the following specified environmental operating conditions. Drive shall be capable of operation in the 'forward' and 'reverse' direction.
   1. Operating Ambient Temperature: 0°C to 40°C.
   2. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
   3. Minimum Elevation without Derating: 3300 feet.
   4. The VFD shall incorporate a protective coating on the main control board to conform to IEC60721-3-3 class 3C2 levels.

E. Input Voltage Performance: The drive shall provide full rated output from a line voltage range of -15 / +10% nominal voltage.

F. Controller shall have the functional components listed below:
   1. Door interlocked input circuit breaker/fused switch.
   2. Input rectifier section to supply fixed DC bus voltage.
   3. Smoothing reactor or choke for DC bus.
   4. DC bus capacitors.
   5. Control transformer or switch mode powered from all three phases.
   6. Separate terminal blocks for power and control wiring.
   7. Terminal block for operator controls.
   8. Sine weighted PWM generating inverter section.

G. Enclosure Fabrication:
   1. Enclosure: NEMA 250, Type 1, unless otherwise specified.
   2. Finish: Manufacturer's standard enamel.
   3. Devices shall be factory installed in controller enclosure and functionally tested unless otherwise indicated.

H. Displays: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current). Include meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (VDC).
   9. Set-point frequency (Hz).
   10. Motor output voltage (V).

I. Status Indication Door-mounted display shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.

5. Overcurrent.
6. External fault.

J. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

K. Panel-Mounted Operator Station or KeyPad, Start-stop, auto-manual selector switches with manual speed control potentiometer, and elapsed time meter: NEMA ICS 2, heavy-duty type.

L. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

M. Control Relays: Auxiliary and adjustable time-delay relays.

N. Protection:
1. Input transient protection by means of surge suppressors or equivalent protection.
2. Snubber networks to protect against malfunctions due to system transients.
3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
4. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
5. Motor thermal overload relay(s) adjustable and capable of NEMA Class 10 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
6. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination. Skip frequency feature is acceptable.
7. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection (fuses or circuit breaker).
11. Motor overtemperature fault.
12. Loss of load protection.

O. For a fault condition other than an internal fault, an auto restart function shall provide up to 10 programmable restart attempts. The programmable time delay before each restart shall range from 0 to 10 seconds.

P. The deceleration ramp of the controller shall be programmable for normal and fault conditions. Stop modes shall include: DC injection braking, controlled deceleration to stop and coast to stop.

Q. Upon loss of the analog speed reference signal the following shall be selectable:
1. The VFD follows the programmed deceleration ramp to a controlled stop.
2. The VFD holds the speed based upon the last good value and trigger a warning alarm.

R. The VFD operates at a pre-determined frequency (user programmable).

S. STOP key on the keypad shall be functional at all time, drive mode insensitive.

T. The VFD shall be insensitive to input power phase sequence. Input phase loss detection shall be available.

U. The output frequency shall be parameter setting enabled to fold back when the motor is overloaded (stall prevention).

V. For pump applications, the VFD shall incorporate a forward/reverse pump start sub-routine to assist with clogging.

W. An optional real time clock feature shall be available, which must facilitate the time stamping of any drive trip messages.

X. The VFD shall monitor the main circuit capacitors, control circuit capacitor, in-rush suppression circuit, and cooling fan and shall provide a pre-alarm so that maintenance can be scheduled.

Y. The VFD shall include an output timer function so that peripheral equipment maintenance can be scheduled.

Z. The VFD shall include parameter selectable input and output phase loss protection.

AA. The VFD basic insulation level shall be tested based upon ANSI/IEEE C62.41-1999.

BB. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.

CC. Minimum Efficiency at Full Load: 96 percent.

DD. Overload Capability: 1.1 times the base load current for 60 seconds every 10 minutes; 1.3 times the base load current for 2 seconds every minute.

EE. Starting Torque: 100 percent of rated torque or as indicated.

FF. Speed Regulation: Plus or minus 1 percent with no motor derating.

GG. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.

HH. The drive shall provide self-protection when the load is lost or disconnected without damage to the drive.

II. Acceleration Rate Adjustment: 0.5 - 30 seconds.

JJ. Deceleration Rate Adjustment: 1 - 30 seconds.

KK. Minimum Adjustment Range for the Output Frequency shall be: 0 to 90 Hertz.

LL. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.

MM. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.

NN. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.

OO. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.

PP. Provide adjustable skip frequencies on the drive output (minimum of three ranges).

QQ. Automatic Reset/Restart: Attempts up to 10 restarts after controller fault, on return of power after an interruption, or on undervoltage fault, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load (coasting motor re-start).

RR. Excitation Control will regulate motor output voltage based on torque requirement. Must be able to provide full motor torque when necessary across the operating speed range.

SS. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

TT. Control Transformer: Provide control power transformer for control, 120 volt secondary, fused.

UU. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
    a. 0 to 10-V dc.
    b. 0-20 or 4-20 mA.
    c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs.
e. RS485.
f. Ethernet.
g. Keypad display for local hand operation.

3. Output Signal Interface:
   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.
5. The control power for the VFD digital inputs and outputs shall be 24Vdc, selectable to sink or source. Optional 120Vac control power for the digital inputs and outputs shall be available.
6. The drive control board shall be capable of operating from an independent 24V dc power supply.
7. All logic connections shall be furnished on a removable terminal strip.
8. External devices shall be able to be connected to the terminal strip for starting/stopping the VFD, speed control and indicating operation status.
9. Speed command input shall be by means of:
   a. Keypad.
   b. Analog input.
   c. Serial communications.
   d. Ethernet communications.

VV. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 0900. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.

WW. Control:
1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door or keypad.
2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.

4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass to direct-on-line operation. In this mode the thermal overload relay for the motor must be disabled.

XX. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

YY. Convertible Auxiliary Contacts (additional): Provide two additional convertible normally open / normally closed contacts.

ZZ. Electronic Thermal Overloads: Provide adjustable electronic type thermal overloads. Size protection per motor nameplate data.

AAA. Multiple Motor Thermal Overloads: Provide manual starter disconnect switch with electronic thermal overloads for each individual motor when the VFD is scheduled to server multiple motors. Size protection per motor nameplate data.

2.04 OPTIONS AND ACCESSORIES - DESCRIPTIONS

A. Passive Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating.
   1. When required:
      a. As required to satisfy, the Harmonic Distortion Performance Criteria descripted in Part 2 of this specification.
      b. Per VFD schedule.

B. Active Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating. Provide all VFDs coupled with an Active Harmonic Filter with a minimum three percent (3%) input line reactor; or larger per manufacturer requirements.
   1. When required:
      a. As required to satisfy, Harmonic Distortion Performance Criteria descripted in Part 2 of this specification.
      b. Per VFD schedule.

C. Active Bridge Rectifier Stage: Capable of limiting current harmonic distortion at the drive input terminals.
   1. When required:
      a. As required to satisfy, Harmonic Distortion Performance Criteria descripted in Part 2 of this specification.
      b. Per VFD schedule.

D. Dynamic Braking: The VFD shall incorporate terminals for adding an external braking unit to allow for dissipation of excessive electrical energy from the motor. Provide dynamic braking with load resistor or DC injection braking to provide a means of rapid deceleration of the AC motor within one (1) minute. Adjust the controls to stop the motor within 30 seconds.
   1. When required:
      a. 100HP or larger applications.
      b. VFD served by package engine generator.
      c. Per VFD schedule or other portions of this specification.
      d. All VFDs supplied for fan applications when VFD is not capable of capturing a free spinning load without damage to the VFD or motor.
   2. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds. The following options shall be available:
      a. Adjustable operation frequency, time, and voltage.

b. External line regeneration.

c. Shared DC bus capability systems for multiple drive regeneration.

E. Three-Contactor Manual Bypass:

1. When required: Per VFD schedule.

2. Provide contactors, motor running overload protection, under-voltage and loss of phase protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch or third contactor to allow maintenance of inverter during bypass operation.

3. All bypass circuitry shall be located within the same enclosure as the variable frequency drive.

4. All fire alarm and/or smoke control interconnections (e.g., air handling unit shutdown) shall apply regardless of whether control is through VFD or bypass.

5. Provide a Drive-Bypass Selector Switch.

6. When operating in bypass mode, the main power supply to the VFD shall be disconnected and isolated for service.

7. Provide nameplate with instructions for switching from drive to bypass and from bypass to drive. Provide instructions for isolating VFD for maintenance.

F. Shielded VFD Motor Cable:

1. When required:

a. Per VFD schedule.

b. Required by other portions of this specification.

c. Recommended by the manufacturer.

2. Multi-conductor single overall jacket cable, AC motor application controlled by PWM pulse-width modulation VFD applications, minimum 2000 volt rated, copper phase conductor(s) to match motor application and ratings, three copper conductor ground in direct contact with shield, copper tape or braided shield, provide with wire termination kits at VFD and motor, install per manufacturer recommendations.

3. Conduit Raceway: Contractor to size raceway per code and cable cross sectional area provided by manufacturer.

4. Installation: Contractor shall install without cable splices between VFD and motor unless approved by engineer prior to installation.

G. Forced Cooling / Heating Cabinet Enclosure:

1. When required:

a. Per VFD schedule.

b. When VFD is located exterior to the building or specified with a NEMA 3R, 4, 4X, or 12 enclosure.

2. Provide custom VFD enclosure with DX based cooling system, strip heaters, and thermostat temp controller.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. Refer to startup and commissioning requirements.

B. The VFD and all associated controller components shall be covered by a supplier parts warranty of 2 years from the time of installation. There shall be an option to extend the warranty to 5 years if initial installation is carried out by a supplier-approved contractor.

3.02 INSTALLATION

A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.

B. Install harmonic filter components in accordance with manufacturer’s instructions. Locate filters above or below VFD to minimize use of available horizontal wall space pending field conditions.

C. Adjust VFD settings per recommendations of the harmonic filter manufacturer's instructions; example: switching frequency.

D. VFD Output Feeder and Raceway: The contractor shall provide VFD shielded cable for the VFD output feeder when the distance to the motor exceeds manufacturer recommendations or the requirements of this specifications. Contractor to size raceway per code and cable cross sectional area provided by manufacturer.

E. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.

F. Provide engraved phenolic nameplates under the provisions of Section 26 0553.

G. Connections: All conduit connections to the VFD shall be by flexible conduit.

H. Input, output, and control wiring shall each be run in separate conduits.

I. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.

J. Forced Cooling / Heating Cabinet Enclosure: Coordinate installation with field conditions and manufacturer instructions. Provide additional branch circuit(s) for cooling and heating system per manufacturer requirements.

3.03 STARTUP AND COMMISSIONING

A. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.

B. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.

C. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.

D. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.

E. Document settings in the Operations and Maintenance manual.

END OF SECTION

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SECTION 26 3213
PACKAGED ENGINE GENERATOR SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system
B. Heat exchanger
C. Exhaust silencer and fittings
D. Fuel fittings and day tank
E. Fuel polishing system
F. Remote annunciator panel
G. Battery and charger
H. Weatherproof enclosure

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 22 3000 - Plumbing Equipment
B. Section 23 2100 - Hydronic Piping
C. Section 23 5700 - Heat Exchangers

1.03 REFERENCES

A. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
B. ANSI/NEMA AB 1 - Molded Case Circuit Breakers
C. ANSI/NEMA MG 1 - Motors and Generators
D. NFPA 37 - Installation and Use of Stationary Combustion Engines and Gas Turbines
E. NFPA 70 - National Electrical Code (NEC)
F. NFPA 110 - Standard for Emergency and Standby Power Systems
G. Environmental Protection Agency EPA Emission Standards for Compressed Ignition Engines
H. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at property boundaries due to sound emitted by the generator set, its components and the operation thereof.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.
B. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
C. Submit product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.
D. Submit certification for EPA Emissions Standards for Compressed Ignition Engines.
E. Submit manufacturer's installation instructions under provisions of Section 26 0500.

1.05 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Section 26 0500.
B. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal toolbox.

C. Provide two additional sets of each fuel, oil, and air filter element required for the engine generator system. Provide additional fuel polishing filters for one year of operation.

D. Provide one fuse for every type and rating used.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 0500.

B. Store and protect products under provisions of Section 26 0500.

C. Accept packaged engine generator set and accessories on site in crates and verify damage.

D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.07 SYSTEM DESCRIPTION

A. Engine generator system to provide source of emergency and standby power.

B. System Capacity: 500 KW, 625 KVA at an elevation of 1,000 feet above sea level, and ambient temperature between -20°F and 110°F; standby rating using engine-mounted radiator.

C. Emergency Power Supply System (EPSS) shall be NFPA 110 Type 10 Class 6 Level 1.

D. Operation: In accordance with ANSI/NFPA 99.

1.08 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 26 0500 for required generator electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings. Show generator, fuel system components, battery system components, and exhaust system in 1/4" scale plan of room.

1.09 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 26 0500.

B. Accurately record location of engine generator and mechanical and electrical connections.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in packaged engine generator system.

B. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 50 miles of the project site.

1.12 WARRANTY

A. Provide a two (2) year warranty under provisions of Section 26 0500.

1.13 MAINTENANCE SERVICE

A. Furnish service and maintenance of packaged engine generator system for one (1) year from Date of Substantial Completion. Maintenance service shall be performed by skilled employees of manufacturer's designated service organization. Include quarterly exercising, and routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts, supplies, and labor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Caterpillar.

B. Cummins Power Generation.

C. Kohler.

D. MTU On Site Energy.

E. GE Waukesha.

2.02 PACKAGED ENGINE-GENERATOR SET (GEN-500)

A. Packaged engine-generator set shall be a coordinated assembly of compatible components. Stationary generators shall be listed.

B. Safety Standard: Comply with ASME B15.1 and UL 2200.

C. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, model and serial number, and component rating in integrated set and as required by the contract documents.

D. Fabricate engine-generator set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.

E. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the generator-set center of gravity.

2.03 ENGINE

A. Type: Water-cooled in-line or V-type, compression internal combustion engine.

B. Rating: Sufficient to operate at 100 percent load for two hours at specified elevation and ambient limits.

C. Fuel: Appropriate for use of No. 2 fuel oil.

D. Engine Speed: 1800 RPM.

E. Governor: Isochronous type with speed sensing.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

G. Frequency Response:

1. Steady State Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
2. Transient Response: Less than 5 percent for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady state operating band within 5 seconds.

H. Fuel System: Engine mounted diesel fuel pump and relief-bypass valve.

I. Fuel Supply System:

1. Base-Mounted Fuel Tank: UL 2085 listed fuel tank with 12 hour rated (NFPA 110 minimum run time by class) capacity. Integral rupture basin with leak detection. Provide fueling port with an overfill prevention type receptacle and lockable cap for exterior units. The tank shall include structural steel supports for top mounted engine generator set. Furnish complete with flexible fuel line connectors lockable cover, and analog level gauge. Furnish complete with float switches to indicate low 5% 25% 50% and 75% fuel level. The footprint of the base-mounted fuel tank shall not exceed the footprint of the generator frame for interior applications or the footprint of the enclosure for exterior installations.
2. Fuel Cooler: Provide unit-mounted fuel cooler with all required hoses, fittings and mounting hardware. Generators without a unit-mounted radiator shall have an integral fan powered by a 120V circuit.

J. Fuel Polishing System:

1. Fuel polishing system capable of removing 99% of emulsified water and particulate down to 3 microns from the fuel. The system shall be sized so the stored fuel capacity shall be polished at least once per week. The system shall include a pump to circulate the fuel from the storage tank through the filter/separator and return it to the tank, A gauge or alarm shall provide notification when a filter is due for change. A timer shall be set to run the pump during off peak hours.

K. Lubrication System: Engine or skid mounted filter and strainer, thermostatic control valve capable of full flow and designed to be fail safe, and crankcase drain arranged for gravity drainage with siphon or pump.

L. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F, and suitable for operation on 277 volts AC. The minimum wattage of the heater shall be watts or as recommended by the manufacturer.

M. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator set mounting frame and integral engine-driven coolant pump.

1. Fan and Core: Nonferrous-metal construction sized to contain expansion of total system. Blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator Airflow Restriction: 0.5 inches of water, maximum.
2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosive additives.
3. Provide expansion tank with gage glass and petcock, and self-contained, thermostatic-control temperature control valve.

N. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel. Provide the following accessories:

1. Battery: Voltage to match starter with capacity for three cranking cycles without recharge. Provide with battery cables and acid resistant battery tray.
2. Battery-Charging Alternator: Factory mounted on engine with solid state voltage regulation.
3. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.
4. BC-# Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
5. Provide two battery strings, two DC power supply/chargers with monitoring, and a best battery selector system. Each shall be sized to provide total starting capacity.
6. DC Power Supply/Charger: Utility grade current limiting type with battery temperature compensation designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave filtered rectifier, digital DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
7. Best battery selector system for dual battery single load configuration. Solid-state design must isolate battery strings from each other.

O. Exhaust System: Industrial type silencer (20 to 75 Hz frequency range; 87 dBA max at 25 feet), side inlet with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. Silencer shall include a threaded opening for connection of ¾" drain line. Opening shall be flush on inside of silencer.

P. The packaged engine generator shall be certified with the current Environmental Protection Agency EPA Emissions standards.

Q. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine-generator control panel.

R. Mounting: Provide unit with suitable spring-type vibration isolators.

2.04 GENERATOR

A. Generator: ANSI/NEMA MG 1; three phase, re-connectible brushless synchronous generator with brushless exciter and PMG alternator excitation.

B. Rating: As indicated on the drawings, at 0.8 power factor, 60 Hertz at RPM to match engine rating.

C. Insulation: ANSI/NEMA MG 1, Class F.

D. Temperature Rise: 105°C continuous.

E. Enclosure: ANSI/NEMA MG 1; open drip-proof.

F. Voltage Regulation:

1. The maximum instantaneous voltage dip (IVD) shall be 28 percent.
2. Include solid-state type voltage regulator, separate from exciter to match engine and generator characteristics, with voltage regulation ±1 percent from no load to full load. Include manual controls to adjust voltage drop ±5 percent voltage level, and voltage gain.

G. Subtransient Reactance (X'd): Maximum 15 percent.

H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.05 CONTROLS AND INDICATION

A. Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator set vibration.

B. Ground Fault: Provide ground fault sensing at the generator. The sensor shall be located ahead of the generator service disconnect. Provide a ground fault indication on the engine-generator control panel. Provide an instruction nameplate at the control panel.

1. Instruction nameplate: Provide operational instructions for a ground fault indication as approved by the local Authority Having Jurisdiction.

C. GCP-#; Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:

1. Alarm indication as required by NFPA 110 for a Level 1 system.
2. AC frequency meter.
3. AC output voltmeter with phase selector switch.
4. AC output ammeter with phase selector switch.
5. Output voltage adjustment.
6. DC voltmeter (alternator battery charging).
7. Engine start/stop selector switch.
8. Engine running time meter.
9. Oil pressure gauge.
10. Engine coolant temperature gauge.
11. Shut down devices for overspeed, coolant high-temperature, coolant low-level, and oil low-pressure.
12. Fuel derangement alarm.
13. Generator overload.
14. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
15. Remote Alarm Contacts: Pre-wire SPST contacts to terminal strip for remote alarm functions required by ANSI/NFPA 99.
16. Ground fault indication.
17. Generator control and start signal failure.
18. 80% load alarm.
19. 85% load Alarm

20. 90% load alarm
21. 95% load alarm
22. Key switch, three-position selection switch.

D. Remote Engine Manual Start Control: Two-wire remote start control from fire command center. Provide all interconnecting wiring in conduit per manufacturer's requirements (by the Electrical Contractor).

E. Building Automation System Integration:

1. Provide a terminal block to allow the Facility Monitoring and Control System (FMCS) to report generator alarms. Provide individual terminal points for each of the annunciator alarms and pre-alarms. Provide an additional terminal point to combine all generator alarms under a single terminal point. Provide a permanent label for each terminal point. Each terminal will provide a binary output for the FMCS to read. Refer to Section 23 0900 for alarms reported by the FMCS.

2.06 ACCESSORIES

A. Generator Circuit Breaker: Molded or insulated case, service-rated thermal-magnetic type; 100% rated breaker complying with NEMA AB1 and UL 489. The disconnect shall simultaneously open all associated ungrounded conductors and be lockable in the open position.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator is shut down by other protective devices.
4. Mounting: Provide freestanding enclosure or mount integrally with control and monitoring panel.
5. The disconnecting means shall also shut down the prime mover, disable all start control circuits, and be configured with a mechanical reset.

B. EPO; Remote Manual Stop Station (Emergency Power Off EPO): Provide a remote manual stop station with weather proof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable cover/lens to access mushroom button, 120-volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator annunciator panel.

C. Remote Fuel Fill Station (RFFS-#): Provide a remote fuel fill station including a fill port within a surface-mounted, lockable, NEMA 3R stainless steel construction with gasketed hinged door and lockable handle. The fill port shall have a minimum overflow holding capacity of five (5) gallons. The fill port inside the cabinet shall be field coordinated. Provide dust cover for fill connection. Include local light and horn alarm with test switch and silence feature when tank level is above 95 percent full. Provide additional float switch in tank for level indication. Include the following accessories:

1. Solenoid valve to prevent additional fuel delivery to the tank when full; 120-volt power provided by Contractor.
2. Lockable drain valve for overflow.
3. Local analog gauge of main tank fuel level.
4. Local digital gauge of main tank fuel level.

D. Dual Source Fuel Filter:

1. High volume, selectable dual path, minimum two high-capacity filters, with water separation, and remote monitor / alarm.
2. Operation Functionality: Selectable path, primary and standby filter. Ability to switch between filters, replace filters, and bleed filters during generator operation.
3. Remote monitor / alarm feature wired to generator control and annunciator panel.

E. Provide dual redundant engine starters. The redundant engine starters shall be configured to start the engine when the primary engine starter fails.

2.07 OUTDOOR GENERATOR-SET ENCLOSURE SKIN-TIGHT

A. Prefabricated or pre-engineered skintight enclosure with the following features:

1. Construction: Reinforced galvanized steel, metal clad, integral structural steel framed housing anchored to a concrete foundation. Panelized aluminum housing with integral structural framing anchored to a concrete foundation. Construction shall allow access to control panels and service points. The panels shall enclose all components, including intake/exhaust louvers and sound attenuators. Extend the enclosure base frame as required for panels.
2. The generator control panel shall be located no greater than 5'-0" above finished grade for ease of access.
3. Structural Design and Anchorage: Wind resistant up to 100 mph.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents. Motor operators shall be spring open, power close operating at 24 volts DC. The louvers shall be connected to the generator starting batteries through appropriate control relays. Louvers shall not extend outside main generator enclosure.
5. Hinged Doors: Provide a minimum of four doors with padlocking provisions. Single doors shall be 36" wide and 84" high. Double doors shall be 60" wide and 84" high. As standard, doors shall include rain-rail moldings above all door openings, recessed, keyed mortise locks, panic bar door hardware and full weather-stripping. Doors shall be removable.
6. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits as required by engine-generator-set components.
7. Fuel Tank Vent: Provide vent piping from the fuel tank to the exterior of the enclosure.
8. Fuel Fill: Provide fill access on the exterior of the enclosure at an elevation not to exceed 5'-0" above finished grade.
9. The exhaust system silencer shall be installed within the enclosure housing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work and field dimensions are as shown on the drawings.

B. Verify that required utilities are available in proper location and ready for use.

C. Beginning of installation means installer accepts existing conditions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install remote manual stop station in location shown on plans. Provide 120 Volt power and wiring in conduit as required. Coordinate installation with the manufacturer approved shop drawings and wiring diagrams. The remote manual stop station shall shunt trip the generator mounted circuit breaker and signal the engine prime mover to stop.

C. The A-B-C phase rotation of the generator source shall match the A-B-C phase rotation of the utility source. The Contractor shall verify the generator and utility phase rotation match to prevent three phase motors and similar loads from operating backwards while being served by the generator.

3.03 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 0500 and in compliance with NFPA 110 requirements.

B. Provide portable test bank for full load test, if required. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.

C. Fill fuel tank prior to start of test.

D. The on-site installation test shall be conducted as follows:

1. With the prime mover in a "cold start" condition and the emergency load at standard operating level, a primary power failure shall be initiated by opening all switches or breakers supplying the primary power to the building or facility.
2. The test load shall be that load that is served by the Emergency Power Supply System (EPSS).
3. The time delay on start shall be observed and recorded.
4. The cranking time until the prime mover starts and runs shall be observed and recorded.
5. The time taken to reach operating speed shall be observed and recorded.
6. The voltage and frequency overshoot shall be recorded.
7. The time delay on transfer to emergency power for each switch shall be recorded. Life safety and critical branch transfer switches must transfer within 10 seconds.
8. The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.
9. The voltage, frequency, and amperes shall be recorded.
10. The prime mover oil pressure and water temperature shall be recorded, where applicable.
11. The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter.
12. When primary power is returned to the building or facility, the time delay on retransfer to primary for each switch with a minimum setting of 5 minutes shall be recorded.
13. The time delay on the prime mover cool down period and shutdown shall be recorded.
14. Allow prime mover to cool for 5 minutes.
15. A load shall be applied for 4 hours total. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate rating of the Emergency Power Supply (EPS), less applicable derating factors for site conditions. Observe and record load changes and the resultant effect on voltage and frequency.
16. The full load test shall be initiated immediately after the cooling time has expired by any method that starts the prime mover and, immediately upon reaching rated rpm, picks up 100 percent of the nameplate kW rating on one step, less applicable derating factors for site conditions.
17. During test, record the following at 5-minute intervals for the first 15 minutes and every 15 minutes for the rest of the test:
    a. Kilowatts
    b. Amperes
    c. Voltage
    d. Frequency
    e. Coolant temperature
    f. Enclosure temperature (interior)
    g. Oil pressure
    h. Engine exhaust temperature
    i. Engine inlet temperature
    j. Oil Temperature
    k. Battery charge rate

18. Upon completion of the test and after a cool down period, the crank/rest cycle shall be tested.
    a. Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.
    b. The control switch shall be set at "run" to cause the prime mover to crank.
    c. The complete crank/rest cycle shall be observed and recorded.
19. Test alarm and shutdown circuits by simulating conditions.

E. Contractor shall fill fuel tanks upon completion of test.

F. Testing documentation shall be submitted to the Architect/Engineer for review and approval.

G. Generator testing worksheets are included with this specification section.

3.04 MANUFACTURER'S FIELD SERVICES

A. Prepare, start, test, and adjust systems under provisions of Section 26 0500.

B. Provide UL field inspection of generator.

3.05 ADJUSTING

A. Adjust generator output voltage and engine speed.

3.06 CLEANING

A. Clean work under provisions of Section 26 0500.

B. Clean engine and generator surfaces. Replace oil and fuel filters.

3.07 DEMONSTRATION

A. Provide systems demonstration. Coordinate the demonstration schedule with the Owner and Architect/Engineer.

B. Describe loads connected to emergency and standby systems and restrictions for future load additions.

C. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

END OF SECTION

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SECTION 26 3600
TRANSFER SWITCH

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Automatic transfer switch with delayed transition ATS-#

B. Portable generator connection cabinet (GCC-#)

1.02 RELATED SECTIONS AND WORK

A. Refer to the Transfer Switch Schedule for rating and configuration.

1.03 QUALITY ASSURANCE

A. Manufacturer: Company specializing in automatic transfer equipment.

1.04 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control and Systems

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

D. NEMA ICS 10 - Guide to Application of Low-Voltage Automatic Transfer Switch Equipment

E. UL 1008 - Standard for Automatic Transfer Switches

F. NFPA 110 - Standard for Emergency and Standby Power Systems

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Submit product data for transfer switches showing overall dimensions, electrical connections, electrical ratings, and environmental requirements.

C. Submit manufacturer's installation instructions under provisions of Section 26 0500.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Include instructions for operating equipment.

C. Include instructions for operating equipment under emergency conditions when engine generator is running.

D. Identify operating limits which may result in hazardous or unsafe conditions.

E. Document ratings of equipment and each major component.

F. Include routine preventive maintenance and lubrication schedule.

G. List special tools, maintenance materials, and replacement parts.

1.07 REGULATORY REQUIREMENTS

A. Conform to applicable code for emergency and standby electrical systems.

PART 2 - PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH WITH DELAYED TRANSITION

A. Automatic transfer switch, microprocessor controlled, three-position switch mechanism, delayed transition and load shed capable, with local manual operation.

B. Acceptable Manufacturers, Standard Grade:

1. Schneider Electric ASCO 300 Series
2. Siemens Russelectric RMT Series
3. ABB Zenith ZTG Series
4. Caterpillar CTG Series

5. Cummins OTPC Series
6. Generac W Series
7. Kohler KCS Series

C. Description: NEMA ICS 2; automatic transfer switch.

D. Configuration: Electrically-operated, three-position delayed transition / off capable, mechanically-held transfer switch.

E. Control panel shall be micro-processor based.

2.02 PORTABLE GENERATOR (GCC-#

A. Acceptable Manufacturers:

1. Foxfab FFCC Series
2. Berthold Electric Co
3. Power Temp Systems Inc
4. ESL Power Systems Triple Switch Series
5. Trystar

B. Pad mount, powder coat painted NEMA 3R housing with lockable door, 800 amps, 600 volt. Color-coded cam-lock connectors. Submit product data and dimensioned drawings. Color selection by Architect.

1. Cam Lock Configuration: Power flow from female to male; note ground / neutral configurations are opposite of phase conductors at the same connection location.

C. Kirk Key Interlock: Provide a kirk key interlock between the permeant generator and the temporary generator disconnect.

D. Three-way Manual Transfer Switch: Provide-three-way switch to allow flexible connection between; onsite generator and load bank, portable generator and load, onsite generator and load.

2.03 SERVICE CONDITIONS

A. Service Conditions: NEMA ICS 1. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

2.04 RATINGS

A. Refer to the electrical diagrams for the Withstand and Close Ratings WCR available interrupting capacity (AIC) at the transfer switch. The transfer switch shall be series rated with the equipment feeding the transfer switch. The series rating shall be the larger of the two Short Circuit Current Ratings SCCR values when the SCCR rating of the equipment feeding the normal and emergency sides of the transfer switch is not equal.

B. Series rating with upstream devices shall be allowed per UL-1008.

2.05 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.

E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

2.06 ENCLOSURE

A. Enclosure: NEMA ICS 6; Type 1.

2.07 ACCESSORIES

A. Load Shed:

1. The controller shall be capable of being programmed to automatically shed the connected load from the generator in the event of a user configurable under- frequency, under-voltage or overload condition. Under-frequency shedding shall occur if generator is less than 58Hz for greater than 3 seconds or less than 50 Hz for greater than 0.5 seconds.
2. Switch shall be configurable to pick up an output status relay upon activation of the auto load shed feature. Output shall be usable to trip/isolate downstream loads in the event of an overload.
3. Reset of the auto load shed function shall be via operator reset on display, remote reset contact input, or via network signal.

B. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.

C. Test Switch: Key operated or password protected switch. Mount in cover of enclosure to simulate failure of normal source.

D. Engine Start Signal: Rated 10 amps at 30VDC shall be provided to start the engine generator in the event of a normal source outage.

E. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.

F. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

G. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed indicating switch to normal source or emergency source.

H. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value, values shall be field adjustable.

I. Alternate Source Monitor: Monitor each line of alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent Hertz from rated nominal voltage, values shall be field adjustable.

J. Engine Exerciser: Start engine every 28 days. Run for 30 minutes before shutting down. Each event shall be configurable for Test with Load or Test Without Load. Bypass exerciser control if normal source fails during exercising period.

K. In-Phase Monitor: Inhibit transfer until source and load are within 30 electrical degrees.

L. Provide 2 N.O. and 2 N.C. isolated contacts to indicate:

1. Normal source available.
2. Emergency source available.
3. Exercise mode in operation.

M. Serial Communication Port: Two twisted pairs of shielded communication cable in conduit shall daisy chain all transfer switches with a remote annunciator.

N. Annunciators shall be located where shown on the drawings, as directed by the Owner. Extend conduit and wire as required by the manufacturer.

O. An adjustable emergency to normal pre-signal signal to elevator controller.

P. Metering Capabilities: The following metered readings shall be available at the local display.

1. Current, per phase RMS and neutral
2. Current unbalance %
3. Voltage, phase-to-phase and phase-to-neutral
4. Voltage unbalance %

5. Real power (KW), per phase and 3-phase total
6. Apparent power (KVA), per phase and 3-phase total
7. Reactive power (KVAR), per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency
10. Accumulated energy, (KWH, KVAH, and KVARH)
11. Demand, (KWH, KVA)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as instructed by the manufacturer.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means acceptance of existing conditions.

3.02 CONTROL AND SIGNAL CABLING

A. Provide control and signal cabling per manufacturer recommendations for the following systems components:

1. Remote annunciator.
2. Generator start signal. The generator start signal cabling for the following transfer switches shall be fire protected for a minimum of 2 hours using an approved method:
    a. Life safety, equipment branch transfer switches
    b. Approved Methods:
        1) Raceway or cable encased in a minimum of 2 inches of concrete cover.
        2) Listed fire resistive raceway / cable system.
        3) Raceway / cable is protected by a listed electrical circuit protective system.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 26 4100
LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Air terminals and interconnecting conductors

B. Grounding and bonding for lightning protection

1.02 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 26 0526 - Grounding and Bonding

B. Section 26 4300 - Surge Protection Devices

1.03 REFERENCES

A. ANSI/NFPA 780 - Lightning Protection Code

B. ANSI/UL 96 - Lightning Protection Components

C. LPI-175 - Lightning Protection Institute Installation Standard

D. LPI-176 - Lightning Protection Institute System Material and Components Standards

E. UL 96A - Installation Requirements for Lightning Protection Systems

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Shop drawings shall indicate layout of air terminals, grounding electrodes, and bonding connections to structure, ground grid, and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details. Include indications for use of raceway and type, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Product data shall show dimensions and materials of each component, and include indication of listing in accordance with ANSI/UL 96 or a nationally recognized testing laboratory.

D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.

E. Submit manufacturer's installation instructions under provisions of Section 26 0500.

F. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

G. Field inspection reports indicating compliance with specified requirements.

1.05 SYSTEM DESCRIPTION

A. Lightning Protection System: System protecting the new Kitchen and Laundry building addition, consisting of air terminals on roofs, roof-mounted mechanical equipment, and penthouse roofs; bonding of structure and other metal objects; grounding electrodes; and interconnecting conductors. Class I materials shall be used for systems on structures not exceeding 75 feet in height. Class II materials shall be used for systems on structures exceeding 75 feet in height above grade.

B. Performance Statement: This specification and the accompanying roof plans describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every air terminal, conductor, and connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all equipment and wiring required for a complete and operational system.

1.06 PROJECT RECORD DOCUMENTS

A. Submit project record documents under provisions of Section 26 0500.

B. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

C. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment and a member of the Lightning Protection Institute or who is listed by a nationally recognized testing laboratory.

B. Installer: Authorized installer of manufacturer and certified by the Lightning Protection Institute.

C. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.08 PRE-INSTALLATION CONFERENCE

A. Convene a pre-installation conference one week prior to commencing work of this Section.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Section 26 0500.

B. Coordinate the work of this Section with exterior and interior finish installations. Coordinate painting of exposed conduits to match building finish with Architect.

C. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

D. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Heary Brothers Lightning Protection Co., Inc

B. Thompson Lightning Protection

C. Harger Lightning Protection

D. Robbins Lightning, Inc

E. Erico International Corporation

F. Burndy Thermoweld

G. VFC Lightning Protection

2.02 MATERIALS

A. All materials shall be copper and/or copper-bronze. In locations where the system components are mounted on aluminum surfaces, aluminum materials shall be used to avoid electrolytic corrosion of dissimilar metals.

B. Components: In accordance with ANSI/UL 96 or nationally recognized testing laboratory.

C. Air Terminals: Solid, unless otherwise indicated. Provide air terminals with safety 3/4" sphere tip. Provide swivel adapters to plumb air terminals when mounting on sloping surfaces.

D. Air Terminal for Chimney: Lead-coated copper.

E. Grounding Rods: Copper clad steel.

F. Ground Plate: 18"x18"x0.032" Copper ground plate.

G. Connectors and Splicers: Bronze, unless otherwise indicated.

H. Early Stream Emitter (ESE) Air Terminal: Enhanced air terminal.

I. ESE Mast: Aluminum or stainless steel mast with base and supports designed for 100 mph wind and 1.3 gust factor.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that field measurements are as shown on the shop drawings.

C. Beginning of installation means installer accepts existing conditions.

3.02 PROTECTION OF SURROUNDING ELEMENTS

A. Protect elements surrounding work of this Section from damage or disfiguration.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with ANSI/NFPA 780, UL 96A, and LPI-175.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

D. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view from exterior locations at grade within 200 feet of building.
5. Notify Architect/Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

E. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

F. Bond extremities of metal bodies exceeding 60 feet in vertical length to structural steel members.

G. Provide a ground ring electrode that meets or exceeds minimum requirements in NFPA 780.

1. Bond ground terminals to ground ring electrode.
2. Bond grounded metal bodies on building within 12 feet of ground to ground ring electrode.
3. Bond grounded metal bodies on building within 12 feet of roof to interconnecting loop at eave level or above.

H. Structures exceeding 60 feet in height: Bond lightning protection components with intermediate-level interconnection loop conductors to down conductors and other grounded media at maximum 60-foot intervals.

3.04 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

C. Bi-metal transition fittings shall be used when changing between aluminum and copper conductors.

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 0500.

B. Obtain the services of Underwriters' Laboratories, Inc. to provide inspection and certification of the lightning protection system under provisions of UL 96A to obtain a UL Master Label for system.

C. Install UL Master Label and attach to building at location directed by the Owner.

D. Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

END OF SECTION

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SECTION 26 4300
SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes materials and installation requirements for factory and field wired low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated distribution panels.

1.02 QUALITY ASSURANCE

A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.

B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment.

1.03 REFERENCES

A. ANSI/IEEE C62.33 - IEEE Guide on Testing of MOV components

B. ANSI/IEEE C62.35 - IEEE Guide on Testing of SAD components

C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

D. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits

E. ANSI/UL 1449 Latest Edition - UL Standard for Safety for Surge Protective Devices

F. CBEMA - Computer Business Equipment Manufacturers Association

G. IEC 664 - International Engineering Consortium, Standard for Clamping Voltage

H. NFPA 70 - National Electrical Code (NEC)

I. UL 67 - Listed for Internal Panelboard Transient Voltage Surge Suppressors

J. UL 96A - Devices listed as approved for secondary surge arrestors (VZCA)

K. UL 248-1 - Fusing

L. UL 1283 - Electromagnetic Interference Filters, Fifth Edition

1.04 SUBMITTALS

A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.

B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

1.05 SPARE PARTS

A. Surge Protection Modules: Furnish 1 replacement module for each type installed.

B. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

1.06 TESTING, WARRANTY AND LIFE EXPECTANCY

A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.

1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.
2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).
3. A single 8 x 20µs waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.

B. Minimum Repetitive Surge Current Capacity:

1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
2. Minimum Repetitive Surge Current Capacity Test:
   a. An initial UL 1449 surge defined as 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
   b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50µs 10kV or 20kV open circuit voltage waveform and an 8 x 20µs 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
   c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.
4. Proof of such testing shall be the test log generated by the surge generator.

C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.

D. Warranty: Ten (10) years. Includes workmanship, installation and programming.

E. No scheduled parts replacement or preventative maintenance shall be required.

PART 2 - PRODUCTS

2.01 DESCRIPTION

A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems.

B. Short Circuit Current Rating: Provide factory label for SCCR rating. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

2.02 RATINGS

A. SPD-1 Secondary Distribution Suppressors:

1. For 277/480-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
   a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
   b. Nominal Discharge Current (IN): 20 kA.
   c. Mounting: Refer to the drawings.

d. Voltage Protection Rating: Refer to requirements below.

e. Components: Minimum component size of 20mm metal thermally protected oxide varistors (MOV).

2. Manufacturers:

a. Square D Surgelogic EMA Series

b. Siemens TPS3 Series

c. Eaton SPD Series

d. Current Technology Current Guard Plus

e. ASCO Power Technologies 400 Series

f. LEA International CFS Series

B. SPD-2 Secondary Distribution Suppressors:

1. For 120/208-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.

a. Surge current capacity: 100,000/200,000 amps per protection mode/phase

b. Nominal Discharge Current (IN): 20 kA.

c. Mounting: Refer to the drawings.

d. Voltage Protection Rating: Refer to requirements below.

e. Components: Minimum component size of 20mm metal thermally protected oxide varistors (MOV).

2. Manufacturers:

a. Square D Surgelogic EMA Series

b. Siemens TPS3 Series

c. Eaton SPD Series

d. Current Technology Current Guard Plus

e. ASCO Power Technologies 400 Series

f. LEA International CFS Series

C. Voltage Protection Rating:

1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).

a. 277/480 Volt, 3 phase, 4 wire.1200 Volt L-N, L-G, N-G and 1800 Volt L-L

b. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L

D. EMI/RFI Noise Rejection or Filtering:

1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.

E. Indication:

1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.

2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.

3. Provide each secondary distribution type unit(s) with a transient counter.

4. Each unit shall contain form "C" contacts for remote indication of an alarm status.

F. Fuses:

1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.

2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.

B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

3.02 INSTALLATION

A. Mounting Location:

1. The unit shall be installed as close as practical to the panel secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the panel using a conduit nipple. Flush mount the unit in the front of the switchboard. Mount unit directly across from the breaker or disconnect serving it.

B. Connections:

1. Conductors from the protected bus to the unit shall not be any longer than necessary avoiding unnecessary bends. The conductor leads shall be twisted together and as short as possible. Connection shall be with mechanical lugs for each phase, neutral, and ground if applicable. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard. Single phase 120-volt units shall be hardwired without a disconnecting means.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

C. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

END OF SECTION

SECTION 26 5119
LED LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires and accessories

B. Exterior luminaires and accessories

C. Light-emitting diode (LED) luminaire systems

D. LED emergency lighting units

E. Emergency exit signs

F. Lighting poles

1.02 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 09 33 Lighting Control Systems
2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.03 REFERENCES

A. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products

B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement

C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment

D. NFPA 70E - National Electrical Safety Code

E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System

F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products

G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED

I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)

J. UL 924 - Standard for Emergency Lighting and Power Equipment

1.04 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Basic Requirements of Submittal:

1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's, LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
3. Include outline drawings, support points, weights, and accessory information for each luminaire.
4. Submit manufacturer origin of LED chipset and driver.

C. LED Lighting - Performance Testing Submittal (when requested by Architect/Engineer):

1. IESNA LM-79: Include photometric report for the latest generation system being furnished. Provide name of independent testing laboratory, report number, date of test, luminaire series/model number, input wattage, and light source specifications.
2. IESNA LM-80: Measuring Lumen Maintenance of LED Light Sources.

D. LED Lighting - Control Compatibility Submittal:

1. Submit lighting control capability data for each LED luminaire. The submittal shall clearly identify device data proposed by the Contractor and approved by the luminaire manufacturer for dimming, switching, addressable, wireless, and similar control characteristics.

E. Submit Design Lights Consortium (DLC) information for each luminaire type.

F. Submit utility rebate forms where offered at project location. Submit completed rebate forms within 30 days of Substantial Completion.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site. Store and protect under provisions of Section 26 0500.

B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.

C. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.06 WARRANTY

A. The warranty period begins at the date of Substantial Completion.

B. LED Light Engines and Drivers:

1. LED Drivers and Dimming Drivers: Five (5) years
2. Light Emitting Diode (LED) Light Engines: Five (5) years

C. Emergency Lighting Units and Exit Signs:

1. Emergency Lighting Units: Three (3) year, non-prorated
2. Exit Signs: Three (3) year, non-prorated
3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.

D. Pole Finish: Three (3) year warranty of pole color and finish

1.07 REGULATORY REQUIREMENTS

A. Conform to NFPA 101 for installation requirements

PART 2 - PRODUCTS

2.01 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.

B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.

C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction.

D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.

E. Painted reflector surfaces shall have a minimum reflectance of 90%.

F. All painted components shall be painted after fabrication.

2.02 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.

B. Provide low temperature LED drivers, with reliable starting to -20°F.

C. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

2.03 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 80. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

B. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

C. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.

D. Rated life shall be minimum of 50,000 hours at L70.

E. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.

F. Luminaire delivered lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.

G. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.

H. LED light engine shall have a maximum LLD of 0.85 at 50,000 hours at 25°C ambient.

I. LED Driver:

1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.
3. Driver shall have a minimum of 50,000 hours rated life.
4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
5. Driver shall be field replaceable without removal of the luminaire.
6. Class A sound rating; inaudible in a 27 dBA ambient.
7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

2.04 LED EMERGENCY LIGHTING UNITS

A. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

B. Battery: Maintenance free lead calcium type, with 90 minute capacity to supply the connected lamp load.

C. Charger: Dual-rate solid state current limiting charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 168 hours. Low voltage disconnect to prevent deep discharge of battery.

D. LED Lamp Wattage: As scheduled on luminaire schedule.

E. Remote Lamps: Match LED lamps on unit.

F. Indicators: Provide lamps to indicate AC ON and RECHARGING.

G. Provide test switch to transfer unit from normal supply to battery supply.

H. Electrical Connection: Knockout for conduit connection.

I. Unit Voltage: Refer to luminaire schedule volts, AC.

J. Self-Diagnostics and Testing:

1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.

2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five-minute discharge/diagnostic test at any time.

2.05 EMERGENCY EXIT SIGNS

A. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.

B. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.

1. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Provide independent support as follows:

a. Luminaires less than 56 lbs.: Provide a minimum of two (2) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires.

b. Luminaires 56 lbs. or greater: Provide a minimum of four (4) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires. Support luminaire independent of the ceiling system.

c. Luminaires larger than eight square feet (8 ft2): Support luminaire independent of the ceiling system.

B. Do not fasten luminaire supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted. Support wires shall be tightly wrapped (minimum of three turns within 3 inches of the connection) and sharply bend to prevent vertical movement.

C. Support suspended or pendant mounted luminaires independent of ceiling grid with adjustable stainless steel aircraft cables or per luminaire schedule mounting requirements. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.

D. Support wire used to independently support luminaires, raceways, and wiring systems shall be distinguishable from ceiling support systems by color (field paint), tagging or equivalent means.

E. Install lamps in lamp holders of luminaires.

F. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.

G. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.

H. Industrial Pendant Luminaires: Use hangers rated 500 pounds minimum or provide safety chain between driver and structure. Provide safety chain between reflector and driver.

I. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.02 CONSTRUCTION USE OF PROJECT LUMINAIRES

A. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

3.03 EMERGENCY LIGHTING UNITS AND EXIT SIGNS

A. Install units plumb and level.

B. Aim directional lamp heads as directed.

C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.04 RELAMPING

A. Replace failed LED light engine modules or arrays at completion of work.

3.05 ADJUSTING AND CLEANING

A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

B. Touch up luminaire and pole finish at completion of work.

3.06 OWNER TRAINING

A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner's Representative.

B. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.07 LUMINAIRE SCHEDULE

A. As shown on the drawings.

END OF SECTION

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SECTION 27 0500
BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Communications Systems.

B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Communications Work a finished and working system.

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Description of Systems include, but are not limited to, the following:

1. Extension of existing Structured Cabling System including, but not limited to:
    a. Voice and data backbone cabling and terminations.
    b. Voice and data horizontal cabling and terminations.
    c. Information outlets (IOs) including faceplates, jacks and labeling.
    d. Equipment racks, cabinets, cable management and equipment.
    e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
    f. Cabling pathways.
    g. Grounding and Bonding
    h. Testing
2. Extension of existing Paging Systems.
3. Mounting and patching of wireless access points provided by others.
4. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
5. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
6. Firestopping of penetrations as described in Division 7.

1.03 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall

the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
3. "Technology Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.
4. Low Voltage Technology Wiring: The wiring (less than 120VAC) associated with the Technology Systems, used for analog and/or digital signals between equipment.
5. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications/technology outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling.

C. General:

1. The purpose of these specifications is to outline typical Electrical and Technology Contractor's work responsibilities as related to technology systems including telecommunications rough-in, conduit, power wiring, and low voltage communications and technology wiring. The prime contractor is responsible for all divisions of work.
2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the technology drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the technology drawings but required for the successful operation of the systems shall be the responsibility of the Technology Contractor and included in the Contractor's bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of technology systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
4. This Contractor shall establish electrical and technology utility elevations prior to fabrication and installation. The Technology Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
    a. Lighting Fixtures
    b. Gravity Flow Piping, including Steam and Condensate
    c. Sheet Metal
    d. Electrical Busduct
    e. Sprinkler Piping and other Piping
    f. Conduit and Wireway
    g. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Responsible for Communications Systems grounding and bonding.

3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the technology bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.05 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
   a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
   b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
   c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
   d. Maintenance clearances and code-required dedicated space shall be included.
   e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
   a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
   a. Scale of drawings:
      1) General plans: 1/4 Inch = 1 '-0" (minimum).
      2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
      3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
      4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).
      5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
   a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
   b. Potential layout changes shall be made to avoid additional access panels.

c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.06 QUALITY ASSURANCE

A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:

a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling

b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises

1) C.1 - Commercial Building Telecommunications Standard

2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard

3) C.3 - Optical Fiber Cabling Components Standard

c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces

d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure

e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

f. ANSI/TIA-862-A - Building Automation Systems Cabling Standard

g. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers

h. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

i. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding

j. NFPA 70 (NEC) - National Electrical Code (Current Edition)

k. UL 444 - Standard for Safety for Communications Cable

B. Refer to individual sections for additional Quality Assurance requirements.

C. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.

2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.

3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.

4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
6. The Contractor must have a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) on-staff serving as a project manager. Project shop drawings and test reports shall be stamped by the RCDD or CNIDP.
7. The Contractor shall obtain the services of a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) for the project. The RCDD or CNIDP shall perform the following tasks on the project:
    a. Review contractor's submittals and stamp the submittals stating the submittals compliance with the contract documents.
    b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks during the construction period.
    c. Provide a final written and dated confirmation of a final construction review prior to testing.
    d. Review final testing of system and indication that the documented results or transmittal of the results stating the test results compliance with the contract documents.
8. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
    a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
    b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
    c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.
    d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
    e. Resume and certification of the RCDD or CNIDP for the project as required by the form at the end of this specification section.
    f. Resume and certification of the BICSI installation technician or CNet CNIT for the project.

D. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the State of Iowa’s Codes, Laws, Ordinances and other regulations having jurisdiction.
2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. Pay any charges by the service provider related to the service or change in service to the project.
8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
    a. Factory Mutual
    b. Underwriters' Laboratories, Inc.

F. Examination of Drawings:

1. The drawings for the technology systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.
3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.07 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
27 05 26	Communications Bonding
27 05 28	Interior Communications Pathways
27 05 53	Identification and Administration
27 11 00	Communication Equipment Rooms
27 13 00	Backbone Cabling Requirements
27 15 00	Horizontal Cabling Requirements
27 17 10	Testing
27 51 13	Paging Systems

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Description of items submitted and relevant specification number
   e. Notations of deviations from the contract documents
   f. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Description of item submitted (using project nomenclature) and relevant specification number
   g. Notations of deviations from the contract documents

h. Other pertinent data

i. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor shall provide proof of RCDD or CNIDP review on the submittal.

d. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

f. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements**.**

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

a. Submittal file name: 27 XX XX.description.YYYYMMDD

b. Transmittal file name: 27 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.08 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.

2. Submit in Excel format.

3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
   a. Material: Delivered cost of product with taxes paid.
   b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
   a. Overhead and profit.
   b. Bonds.
   c. Insurance.
   d. General Requirements: Itemize all requirements.
4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
   a. Structured cabling
   b. Overhead paging systems

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of Subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:

1. Firestopping, including mechanical firestop systems.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.

B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.14 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.01 CABLE JACKET RATING

A. This project requires all cable jackets to carry a plenum rating.

2.02 Refer to individual sections.

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 0533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.03 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 27 sections for further requirements.
2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
5. All communications cable tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other

surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.04 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
2. Submitted bound copies of approved shop drawings.
3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to the project site; submit receipt to Architect/Engineer prior to final payment being approved.
8. Provide System Assurance Warranty certificate for the telecommunications system.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
   a. O&M file name: O&M.div27.contractor.YYYYMMDD
   b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.

E. Refer to the individual specification sections for minimum hours of instruction time for each system.

F. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.

2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 SYSTEM STARTING AND ADJUSTING

A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.08 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of technology drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record actual routing of all conduits sized 2" or larger.

E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.09 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All overhead or integrated paging systems, including speakers, back boxes, cabling, and power supplies, and all headend equipment is installed, programmed and operational.
9. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
10. All access control system equipment, including conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational by Owner security vendor Accurate Controls, Inc.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

TELECOMMUNICATIONS - PROOF OF CERTIFICATION

There are specific Contractor qualification requirements for this project as defined in Section 27 0500, which may include Manufacturer Certification and RCDD or CNIDP credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

Statement of Compliance:

Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the _____ day of _____, 20____.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: _____

Authorized Representative: (print) _____

Date: _____

Manufacturer Certification Number (if any): _____

If this project requires RCDD certification, complete the following:

RCDD or CNIDP Name: _____

RCDD #: _____ Expiration: _____

Submit the following with the bid:

This form.

Proof of Manufacturer Certification indicated above.

Proof of RCDD or CNIDP status.

END OF SECTION

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SECTION 27 0505
TECHNOLOGY DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Technology demolition.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements.

1.03 REFERENCES

A. NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for terminating, patching and cross connecting of existing telecommunications and security systems shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY OUTLET, BOX, CONDUIT, OR CABLE THAT MUST BE REMOVED.

B. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS AND SCOPE OF WORK.

C. Whenever possible, the Contractor shall coil existing cable above ceiling for re-termination if cable length will allow. Re-terminated cables shall be tested for wire map and continuity.

D. Where walls, ceilings, structures, etc., are indicated as being renovated on general drawings, the Contractor shall be responsible for the removal of all technology equipment including but not limited to: copper, fiber and coaxial cable, faceplates and jacks, raceways, racking and equipment mounted to the racking, etc., from the renovated area.

E. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

F. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area.

G. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and technology service to avoid conflicts.

3.02 PREPARATION

A. Not all services within the building will be inactive or abandoned. Verify abandonment status with the building owner, trade contractors and Architect/Engineer prior to demolition.

B. Prior to commencing with demolition, a proposed implementation narrative with schedule shall be submitted to the Architect/Engineer for approval.

C. The contractor shall provide proof that only qualified personnel with extensive telecommunications experience will perform the demolition. No laborers will be allowed in the cable removal process.

D. The contractor shall coordinate with owner to verify all cabling, patch cords and cross connects have been removed from active equipment that is to remain during the duration of the renovation.

E. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on active equipment, use technicians experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

3.03 DEMOLITION AND EXTENSION OF EXISTING TECHNOLOGY WORK

A. Demolish and extend existing technology work under provisions of Division 1 of Architectural Specifications and this Section.

B. Some cabling within the ceiling space may serve other building tenants; care shall be exercised to prevent service interrupts.

C. Remove, relocate, and extend existing installations to accommodate new construction.

D. Remove abandoned low voltage cabling and raceway to source of cabling according to the NEC. Refer to the NEC for definition of Abandoned Communications Cabling.

E. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

F. Disconnect and remove abandoned patch panels, blocks and other distribution equipment.

G. Maintain access to existing technology installations that remain active. Modify installation or provide access panels as appropriate.

H. Extend existing installations using materials and methods compatible with existing technology installations, or as specified.

I. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

J. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Patch panels, blocks and other connectivity equipment: Clean exposed surfaces and check tightness of connections. Re-terminate any loose connections; the contractor shall notify the Architect/Engineer of any permanently damaged or unusable equipment.

C. TECHNOLOGY ITEMS (E.G., PATCH PANELS, EQUIPMENT RACKS, JACKS, FACEPLATES, BLOCKS, CABLING, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.05 INSTALLATION

A. Install relocated materials and equipment under the provisions of applicable Division 27 specifications.

END OF SECTION

SECTION 27 0526
COMMUNICATIONS BONDING

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 26 0513 - Wire and Cable

C. Section 26 0526 - Grounding and Bonding

D. Section 26 4100 - Lightning Protection Systems

E. Section 27 0500 - Basic Communications Systems Requirements

F. Section 27 1100 - Communication Equipment Rooms

G. Section 27 0528 - Interior Communication Pathways

H. Section 27 0553 - Identification and Administration

1.02 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

B. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

1.03 REFERENCES

A. ANSI/IEEE 1100 - Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems

B. ANSI/TIA/EIA 568-C - Commercial Building Telecommunications Cabling Standard

C. ANSI/TIA/EIA 569-A - Commercial Building Standard for Telecommunications Pathways and Spaces

D. ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

E. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements

F. IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding

G. NFPA 70 - National Electrical Code

H. NFPA 780 - Standard for the Installation of Lightning Protection Systems

I. UL 96 - Lightning Protection Components

J. UL 96A - Installation Requirements for Lightning Protection Systems

K. UL 467 - Grounding and Bonding Equipment

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 0500.

B. Store and protect products under the provisions of Section 27 0500.

C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

1.05 SYSTEM DESCRIPTION

A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.

B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.

C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.

D. Basic System Requirements:

1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
2. The bonding system shall include, but not be limited to, the following major components:
    a. Bonding Conductor for Telecommunications (BCT)
    b. Existing Telecommunications Main Grounding Busbar (TMGB)
    c. Telecommunications Bonding Backbone (TBB)
    d. Telecommunications Grounding Busbar(s) (TGB)
    e. Rack mount Telecommunications Grounding Busbar(s)
    f. Bonding Conductor(s) (BC)
    g. Bonding Connectors
    h. Bonding system labeling and administration as defined in Section 27 0553.

1.06 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 0500.

B. Provide final system block diagram showing any deviations from approved shop drawing submittal.

C. Provide floor plans that document the following:

1. Actual locations of system components, devices, and equipment.
2. Actual conductor routing.
3. Actual system component, device, equipment, and conductor labels.

D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.

E. Complete all operation and maintenance manuals as described below.

PART 2 - PRODUCTS

2.01 BONDING CONDUCTORS

A. Bare Copper:

1. Annealed uncoated stranded conductor.
2. Minimum size 6 AWG.

B. Insulated Copper:

1. Annealed uncoated stranded conductor.
2. Insulation:
    a. PVC insulation with nylon outer jacket.
    b. Rated at 600 volts.
    c. Green.

3. Minimum size 6 AWG.

C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.

D. Bonding Conductor Sizing:

1. All communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

2. The BCT shall be the same size as the TBB or larger.

2.02 BONDING CONNECTORS

A. Acceptable Types:

1. Two-hole compression lug
2. Exothermic weld
3. Irreversible compression

B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.

C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

2.03 GROUNDING BUSBAR (TMGB AND TGB)

A. Features:

1. Wall-mount configuration.
2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
4. Predrilled holes.
5. Integral insulators.
6. Stainless steel offset mounting brackets.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
   a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
   a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.

b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

2.04 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

A. Features:

1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
2. Predrilled holes.
3. Mounts in a standard 19" equipment rack.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.
   a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
   a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.
   b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.
2. A licensed electrician shall perform all bonding.
3. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Telecommunications Ground Bar (TGB) Requirements:

1. Provide a TGB in each telecommunications equipment room.
2. Install TGB such that it is insulated from its support with a minimum 2" standoff.
3. Bond each TGB to the TMGB via the TBB.
   a. A minimum of 1 foot separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.
   b. The TBB may be routed from TGB to TGB or as a radial feed to each TGB as the layout requires.
4. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.
5. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.
6. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.
7. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.

C. Metallic Interior Communication Pathway Bonding Requirements:

1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, and ladder rack, shall be bonded to the communications bonding system.

D. Bonding Conductor Requirements:

1. Bonding conductors shall be green or marked with a distinctive green color.
2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.
3. Bonding conductors shall not be installed in metallic conduit.
4. All conductors, including, but not limited, to the BCT, TBB, GE(s), and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.
    a. Where documented permission to splice a conductor is granted:
        1) The number of splices shall be limited to as few as possible.
        2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.
        3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.
        4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.
5. All bonding conductors shall be labeled in accordance with the requirements of Section 27 0553. In addition to the requirements of Section 27 0553:
    a. Labels shall be nonmetallic.
    b. Labels shall be printer-generated.
    c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.
    d. Additionally, conductors shall be labeled as follows:
        1) "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER."
6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.
7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.

E. Bonding Connection Requirements:

1. Make all connections in accessible locations to facilitate future inspection and maintenance.
2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.
3. Thoroughly clean conductors before installing lugs and connectors.
4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.

5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.
6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.
7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

3.02 FIELD QUALITY CONTROL

A. Field testing shall be performed under provisions of Section 27 0500.

B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

3.03 ADJUSTING

A. Adjust work under provisions of Section 27 0500.

B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

3.04 TESTING

A. Test installed system under provisions of Section 27 1710.

B. Measure and document resistance to ground at TGB, each RTGB, and each electrical distribution panel bonded to the TGB.

1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms.
3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.

C. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 1710.

END OF SECTION

SECTION 27 0528
INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 27 0500 - Basic Communications Systems Requirements

C. Section 27 0526 - Communications Bonding

1.02 QUALITY ASSURANCE

A. Refer to Section 27 0500 for requirements.

1.03 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
2. Manufacturer's installation instructions.

B. Coordination Drawings:

1. Include conduit sleeve layout in composite electronic coordination files. Refer to Section 27 0500 for coordination drawing requirements.

1.05 DRAWINGS

A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Refer to Section 26 05 33 for conduit requirements for this project.

2.02 CABLE HANGERS AND SUPPORTS

A. Provide a non-continuous cable support system suitable for use with open cable.

B. Cable Hooks:

1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.

C. Cable Hangers:

1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.
4. Cabling hanger load limit shall be 100 lbs. per foot.

5. Manufacturer:
    a. Erico Caddy
    b. CableCat CAT425
    c. Arlington Fittings Tl Series
    d. Or approved equal.

2.03 INNERDUCT - CORRUGATED

A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.

B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.

C. Solvent-cement type joints as recommended by manufacturer.

D. Inside diameter not less than that of rigid steel conduit.

E. Dielectric strength a minimum of 400 volts per mil.

F. Corrugated wall construction.

G. Pull rope pre-installed by manufacturer.

H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all the above General requirements plus:

1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.
2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).

I. Innerduct installed within building riser shafts shall meet all the above general requirements plus:

1. Be fabricated of flame-retardant materials suitable for installation in such environment.

J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

PART 3 - EXECUTION

3.01 INNER DUCT INSTALLATION REQUIREMENTS

A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

B. All exposed inner duct is to be labeled at 35-foot intervals with tags indicating ownership, the cable type (e.g., "Fiber Optic Cable") and the cables it contains (e.g., MA-CS or FS-CS).

C. Where exposed, fiber optic cable shall be installed in protective inner duct.

D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.

E. The inner duct should extend into the termination enclosure at system endpoints.

F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

3.02 CABLE HOOK SUPPORT SYSTEM

A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.

B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.

C. Cable hooks shall be securely mounted per manufacturer's instructions. In no case shall the side-to-side travel of any cable hook exceed 6".

D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

E. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet.

F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.

G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

3.03 CONDUIT AND CABLE ROUTING

A. Refer to Section 26 0533 for additional requirements.

B. All conduits shall be reamed and shall be installed with a nylon bushing.

C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.

D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.

E. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.

1. A separate pull box is required for each 90' (or greater) length section.
2. A separate pull box is required after any two (2) consecutive 90-degree bends.
3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.

F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.

G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

3.04 ATTACHMENT TO METAL DECKING

A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hangar and a minimum spacing of 2'-0" on center. This 25-lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

END OF SECTION

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SECTION 27 0553
IDENTIFICATION AND ADMINISTRATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the identification and administration requirements relating to the structured cabling system and its termination components and related subsystems.

B. Identification and labeling.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Documentation of labeling scheme.

PART 2 - PRODUCTS

2.01 LABELING

A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.

B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.

C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface an attachment method.

D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.

1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum "quite zone" of 0.25" on each side of the bar code.
2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.

E. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:

1. (Telecom Room Number) - (Patch Panel Letter) - (Patch Panel Port Number).
2. "Telecom Room Number" shall be as indicated on the drawings.
3. "Patch Panel Letter" shall start with 'A' for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.
4. "Patch Panel Port Number" shall start with '1' for the upper left port in each modular patch panel, increasing sequentially from left to right and top to bottom across the modular patch panel face.
5. Example #1: MC/1-A3 indicates the third modular patch panel port in modular patch panel 'A' in Main Equipment Room (MC/1).
6. Example #2: HC/2-C39 indicates the thirty-ninth modular patch panel port in modular patch panel C in Horizontal Cross-Connect room (HC/2).

2.02 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 0500 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

3.01 IDENTIFICATION AND LABELING

A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.

1. Provide additional cable labeling at each manhole and pull box.
2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.
3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.

B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.

END OF SECTION

SECTION 27 1100
COMMUNICATION EQUIPMENT ROOMS (CER)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the products and execution requirements related to furnishing and installing equipment for communication equipment rooms.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

B. Section 27 0526 - Communications Bonding

C. Section 27 0528 - Interior Communication Pathways

D. Section 27 1500 - Horizontal Cabling Requirements

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for applicable standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

PART 2 - PRODUCTS

2.01 EQUIPMENT GROUNDING

A. Refer to specification section 27 0526 for grounding requirements.

B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.02 EQUIPMENT RACKS AND CABINETS

A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.

B. The equipment rack shall conform to the following requirements:

1. Standard TIA/EIA 19" Wall Cabinet:

a. The equipment cabinets shall be constructed of painted steel or aluminum and offer a usable mounting height of 15 RU. Racks shall be a minimum of 21 inches deep. Access to the rear of the cabinet-mounted equipment shall be by a hinged arrangement.

b. The equipment cabinet shall be equipped with a lockable steel front door and furnished with two (2) keys that shall be usable on all cabinets furnished under this Contract.

c. The equipment cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting. The cabinet shall be tapped to accept 12-24 screws.

d. The equipment cabinet shall be vented to allow for airflow through the cabinet.

2.03 CABLE MANAGEMENT - HORIZONTAL

A. Equipment Cabinets

1. Equipment cabinets shall be equipped with vertical and horizontal cable management hardware, in the form of rings and guides, to allow an orderly routing of optical fiber and copper jumpers from the modular patch panels to the customer provided network electronics. At a minimum, one such horizontal cable management panel shall be provided with each equipment cabinet. Horizontal

cable management panels shall be 3.5" in height and have a minimum of five (5) jumper distribution rings.

2.04 PATCH PANELS

A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.

B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 1500.

C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.

D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.

E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

2.05 OPTICAL FIBER PANELS

A. All terminated optical fibers shall be mated to simplex LC-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted.

B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.

C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.

D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.

E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or ½½", whichever is larger.

F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.

G. Where "Loose Buffered" cables are installed, the 250 µµm coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtails") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar¢¢) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µµm coated optical fibers shall not be permitted.

H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.

2.06 OPTICAL FIBER COUPLERS/ADAPTERS

A. Optical Fiber Couplings (LCtype) (Multimode/Singlemode):

1. LC-type optical fiber couplings shall be used to terminate optical fiber backbone cable on fiber distribution cabinet panels in communication equipment rooms. Horizontal optical fiber cables shall also be terminated using optical fiber couplings at their designated work area locations on information outlet faceplates for "fiber to the desk."
2. LC-type optical fiber couplings shall be snap-type with locking washer and nut.
3. LC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber couplings shall accept 125-micron outside diameter multimode fiber.
5. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.
6. LC-type optical fiber couplings shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Performance Requirements:
   a. Length: 2 inches
   b. Operating Temperature: -40 to 85 degrees C
8. Basis of Design:
   a. Hubbell

2.07 D-RINGS

A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.

B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.

C. Provide 1/4" screw holes for wall mounting.

2.08 POWER STRIPS

A. Provide power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:

1. Standard Rack Mount:
   a. TIA/EIA 19" equipment rack mountable.
   b. Compliant with UL-1449 Third Edition and UL-497A.
   c. Provide transient suppression to 12,000-A. Protection shall be in all three modes (line-neutral, line-ground and neutral-ground).
   d. Shall meet or exceed ANSI C62 Category A3 requirements.

e. Provide high-frequency noise suppression as follows:
   1) Greater than 20-dB @ 50 kHz
   2) Greater than 40-dB @ 150 kHz
   3) Greater than 80-dB @ 1 MHz
   4) Greater than 30-dB @ 6 to 1000 MHz
f. Protection Modes and UL 1449 Clamping Voltage: 475 volt L-N, L-G, and N-G.
g. Components: Nonmodular units composed of 20mm metal oxide varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.
h. Be equipped with a 10-foot power cord.

2.09 COPPER PATCH CORDS

A. Modular Patch Panel:
1. Provide Category 6 copper patch cords for 50% of all assigned ports on the modular patch panel. Of these cords, 60% shall be 3' in length and 40% shall be 5' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
2. Refer to Section 27 1500 for cable and connector performance requirements.
3. Patch cords shall not be made-up in the field.

2.10 FIBER PATCH CORDS

A. Optical Fiber Patch Cords (Multimode):
1. Provide 50/125 mm multimode (MM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped LC-type connector on each end and shall be a minimum of 5 feet in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.
2. Channels shall be of equal length.
3. Refer to Section 27 1500 for cable and connector performance requirements.
4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
   a. Hubbell DFPC Series

PART 3 - EXECUTION

3.01 D-RINGS

A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.
B. Locate D-rings on 24" centers vertically and horizontally.
C. Securely attach D-rings to the wall as required by the manufacturer.

3.02 CROSS CONNECT INSTALLATION

A. Bend radius of cable shall not exceed 4 times the outside cable diameter or manufacturer's recommendation, whichever is less.
B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.
C. The cable jacket shall be maintained as close as possible to the termination point.
D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support.

3.03 OPTICAL FIBER TERMINATION

A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.

B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.

C. Each cable shall be clearly labeled at the entrance to all enclosures.

D. A maximum of 12 strands shall be spliced in any tray.

3.04 CONDUITS AND CABLE ROUTING

A. Refer to Section 26 0533 for additional requirements.

B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.

C. All conduits shall be reamed and shall be installed with a nylon bushing.

D. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

END OF SECTION

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SECTION 27 1500
HORIZONTAL CABLING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper cabling.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

B. Section 27 1720 - Structured Cabling System Warranty

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards and plenum or non-plenum cable requirements.

B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).

C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.

D. The installing contractor must be certified by the manufacturer of the structured cabling system.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

PART 2 - PRODUCTS

2.01 HORIZONTAL CABLE

A. CAT 6 Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.
2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
3. Performance tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.
4. Performance data shall be characterized as "Guaranteed Headroom" and shall be guaranteed by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.
5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 1720 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.

6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

Electrical Value (1 - 250 MHz)	Minimum Margin
Insertion Loss:	5%
NEXT:	3.0 dB
PS NEXT:	5.0 dB
ACR-F (ELFEXT):	4.0 dB
PS ACR-F (PS ELFEXT):	5.0 dB
Return Loss:	2.0 dB

7. The jacket color for CAT 6 cable shall be white for voice applications and blue for data applications.
8. Basis of Design:
   a. Hubbell HC6R Series
   b. Additional acceptable manufacturers:
      1) Belden
      2) Berk-Tek
      3) Commscope/Uniprise
      4) Panduit
      5) Siemon
      6) Superior Essex

2.02 FACEPLATES/JACKS

A. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:
   a. Match the receptacle color used for other utilities in the building, or
   b. When installed in surface raceway (if applicable), match the color of that raceway.
7. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
   a. Be a low-profile assembly.
   b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.

c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.

d. Incorporate a shroud that protects the optical fiber couplings from impact damage.

8. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.

9. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.

10. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.

11. CAT 6 modular jacks shall be pinned per TIA-568B.

12. CAT 6 termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:

    a. ANSI/TIA/EIA-568-A-5

    b. ANSI/TIA/EIA-568A

    c. ISO/IEC 11801

    d. IEC 603-7

    e. FCC PART 68 SUBPART F

13. The color for CAT 6 jacks shall be white for voice applications and blue for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6 modular jack.

PART 3 - EXECUTION

3.01 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.

2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.

3. Manufacturer's minimum bend radius specifications shall be observed in all instances.

4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.

5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.

6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.

7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

B. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

1. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
    a. Twelve (12) inches from power lines of less than 5-kVa.
    b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
    c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
    d. Thirty-nine (39) inches from transformers and motors.
2. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

3.02 CABLE TERMINATION REQUIREMENTS

A. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.
2. If the "last" patch (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use.
3. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

END OF SECTION

SECTION 27 1710
TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work, the Contractor shall submit:

1. Complete information on testing procedure as described herein.
2. Test plan summary for each cable type to be tested including equipment to be used, setup, test frequencies or wavelengths, results format, etc.

PART 2 - PRODUCTS

2.01 TESTING COPPER

A. General Requirements:

1. Perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
3. Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results in their native format.
7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.

8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
    a. CAT 6 Cable:
        1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
        2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
        3) CAT 6 horizontal cable shall be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Permanent Link", including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
            a) Wire Map
            b) Length
            c) NEXT Loss (Pair-to-Pair)
            d) NEXT (Power Sum)
            e) ELFEXT (Pair-to-Pair)
            f) ELFEXT (Power Sum)
            g) Return Loss
            h) Attenuation
            i) Propagation Delay
            j) Delay Skew
        4) The maximum length of horizontal cable shall not exceed 295 feet, which allows 33 feet for technology equipment and modular patch cords.
        5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
        6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.
        7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

2.02 TESTING FIBER

A. General Requirements:

1. Perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
3. Visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results.
7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
    a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
    b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.

B. Tests Prior to Installation: The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. Supply this test data to the Architect/Engineer prior to installation.

C. Tests After Installation: Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:

1. Optical Attenuation ("Insertion Loss" Method):
    a. Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers

shall be tested at 850 ±± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ±± 20 nm.

b. Attenuation of optical fibers shall not exceed the values calculated as follows:

1) Attenuation (max.) = 2*C+L*F+S dB.

2) Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices * maximum attenuation per splice).

2. Verification of Link Integrity (OTDR):

a. All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.

b. Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.

c. OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

2.03 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, submit as-builts per the requirements of Section 27 0500 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.

3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (USB thumb drive). The thumb drive shall contain the electronic equivalent of the test results as defined by the bid specification and be in the tester's native format as well as summaries of each test in pdf format. Provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. Furnish one (1) copy of the data and display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 27 1720
STRUCTURED CABLING SYSTEM WARRANTY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements.

B. Section 27 1100 - Communication Equipment Room (CER).

C. Section 27 1300 - Backbone Cabling Requirements.

D. Section 27 1500 - Horizontal Cabling Requirements.

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to close of the project the Contractor shall submit:

1. A numbered certificate from the manufacturing company registering the installation.

PART 2 - PRODUCTS

2.01 WARRANTY

A. A twenty (20) year Product Installation Warranty shall be provided for the structured cabling system as described in the contract documents.

B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

C. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.

PART 3 - EXECUTION

3.01 WARRANTY REQUIREMENTS

A. This Contractor shall be responsible for providing, installing and testing a structured cabling system that will meet the manufacturer's warranty requirements.

END OF SECTION

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SECTION 27 5113
PAGING SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wall-Mounted Compression Horn, Weather Resistant

B. Paging System Cable

C. Conduit

D. Non-Continuous Cable Hangers and Supports

1.02 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 26 0535 - Surface Raceways

C. Section 26 0513 - Wire and Cable

D. Section 27 0500 - Basic Communications Systems Requirements

E. Section 27 0526 - Communications Bonding

F. Section 27 0528 - Interior Communication Pathways

G. Section 27 1500 - Horizontal Cabling Requirements

H. Section 27 0553 - Identification and Administration

1.03 QUALITY ASSURANCE

A. Installer: The Contractor must be a factory-authorized service and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1. The Contractor shall own and maintain all tools and equipment necessary for successful installation and testing of the system and have personnel adequately trained in the use of such tools and equipment.

B. Service: The installer must be factory certified to provide service on the installed manufacturer's equipment and must have local service representatives within 100.

C. The entire installation shall comply with all applicable electrical and safety codes. All applicable devices, equipment, and cabling shall be listed by Underwriters' Laboratories, Inc.

1.04 REFERENCES

A. ADA - Americans with Disabilities Act

B. ADAAG - Americans with Disabilities Accessibility Guidelines

C. NFPA 70 (NEC) – National Electrical Code

D. UL 813 - Standards for Commercial Audio Systems

E. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

F. Code of Federal Regulations Title 29 Subtitle B Chapter XVII Part 1910 Subpart L Section 1910.165 - Employee Alarm Systems

G. ISO R 266-1997

H. ANSI S1.6-1984

1.05 SUBMITTALS

A. Submit product data under the provisions of Section 27 0500.

B. Provide materials documenting experience requirements of the manufacturer and installing contractor.

C. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item by item.
2. All component options and accessories specific to this project.
3. Electrical power consumption rating and voltage.
4. Heat generation for all power consuming devices.
5. Wiring and connection requirements.
6. Manufacturer's installation instructions, indicating application conditions and limitations of use as stipulated by product testing agency and instructions for storage, handling, protection, examination, preparation, installation, and initiating usage of product.

D. Certification Documentation Submittal:

1. Provide documentation of all required certifications. All certifications shall be current and valid. Any certificate with expired dates will not be accepted. Submittal shall include documentation of the following:
   a. System Equipment Manufacturer(s) dealer certification(s) and dealer number(s).
   b. System Equipment Manufacturer(s) programmer certification(s).
   c. All other applicable dealer, installation, and programming certifications.
2. If an alternate manufacturer is submitted, the equivalent certifications to the basis of design manufacturers shall be required and submitted.

E. Provide voltage drop calculations for each speaker cable circuit or run, showing the drop for the specific circuit or run wattage and cable size used.

F. Quality Assurance:

1. Provide list of test equipment proposed for use in testing the installed paging system.
2. Provide system checkout test procedure to be performed at acceptance, including demonstration of specified performance and all required system features and functions listed herein and as further detailed on the drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 0500.

B. Store and protect products under the provisions of Section 27 0500.

1.07 SYSTEM DESCRIPTION

A. This specification section describes the extension of an existing single-zone paging system.

B. Performance Statement: This specification section and the accompanying design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed or every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required for a complete and operational system.

C. This Contractor shall furnish and install paging system speakers as hereinafter specified and further detailed on the drawings. System shall be completely wired and ready for use including, but not limited to, outlet boxes, conduit, wire, equipment and speakers.

1.08 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 0500.

B. Provide floor plans identifying actual locations of all installed overhead paging system equipment and devices.

C. Provide final system block diagram showing any deviations from shop drawing submittal. Block diagram shall include cable number documenting the numbers installed on both ends of the cable in the field.

D. Provide documentation of all test results and statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described herein.

1.09 WARRANTY

A. Unless otherwise noted, provide warranty for a minimum of one (1) year after Substantial Completion, as defined by the Contract. Certain system components may require additional manufacturer's warranty as described herein.

B. The warranty shall:

1. Ensure that all approved devices, equipment, cabling, and other components specified in this section meet or exceed the specified requirements.
2. Ensure against product defects.
3. Cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

C. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - PRODUCTS

2.01 WALL-MOUNTED COMPRESSION HORN, WEATHER RESISTANT

A. Features:

1. Integral 70-volt transformer
2. Weather-resistant molded grey plastic enclosure
3. Integral U-bracket mount

B. Specifications:

1. Power Handling: 15 watts, minimum of 5 transformer tap settings
2. Frequency Response: 400 Hz to 14 kHz
3. Sensitivity: 89 dB

C. Basis of Design:

1. Atlas AP-15T

D. Provide complete with necessary manufacturer's mounting accessories.

2.02 PAGING SYSTEM CABLE

A. Speaker Cable

1. Minimum 18/2 shielded with drain wire
   a. Conductor Type: Bare copper, stranded
   b. Voltage Capacity: 300 volts RMS
   c. Current Capacity: 5 amps per conductor
   d. Nominal Capacitance, Conductor to Conductor: ä? 70 pF/ft.
   e. Nominal Capacitance, Conductor to Shield: ä? 126 pF/ft.
   f. UL Temperature Rating: 75°°C
2. Cable shall be NEC compliant and UL listed.
3. Basis of Design:
   a. Belden 5300FE (CM) or 6300FE (CMP)

4. Provide with larger-gauge conductors where necessary to maintain acceptable voltage drop as defined herein.

2.03 CONDUIT

A. All conduit for paging system cabling shall be a minimum of 3/4" trade size.

B. Flexible conduit shall be used only for "fixture whip" type applications at speakers in accessible ceilings, between a speaker and nearby junction box. Flexible conduit for this application shall be no longer than four (4) feet. Flexible conduit shall not be installed for any other paging system cabling.

C. Refer to Specification Section 26 0533 for additional requirements.

2.04 NON-CONTINUOUS CABLE HANGERS AND SUPPORTS

A. Refer to Section 27 0528 for requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with all manufacturer's instructions and recommendations for installation of all equipment, devices, and materials.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. Wiring:

1. Refer to Sections 26 05 33 for conduit requirements and 26 05 13 for additional wiring requirements. Wiring not installed in conduit shall be plenum rated.
2. All cabling shall be run in conduit "free-air" in non-continuous cable supports or cable tray above accessible ceilings, and in conduit or in a secured metal raceway in exposed areas. Supports shall be spaced at a maximum 4-foot interval. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.
3. All overhead paging system audio cabling, including but not limited to speaker, line-level audio, and microphone-level audio cabling, shall be installed in its own cable pathway and shall not share any raceway or cable pathway with telephone or computer network cabling or cabling of any other system.
    a. Cable shall not be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires. Cables shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, ceiling supports, electrical or communications conduit, or structural elements.
4. Manufacturer's minimum bend radius specifications for cables shall be observed in all instances.
5. All cable shall be installed at right angles and be kept clear of work by other trades. To reduce or eliminate EMI, the following minimum separation distances from £ 480V power lines shall be adhered to:
    a. 12 inches from power lines of 5-kVa
    b. 18 inches from high voltage lighting (including fluorescent)
    c. 39 inches from power lines of 5-kVa or greater
    d. 39 inches from transformers and motors
6. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.
7. All cable shall be free of tension at both ends.
8. Both ends of all cables shall be clearly labeled with an alphanumeric identifier. On speaker cables, the label shall indicate the speaker cable circuit zone or run and the telecommunications room in which the zone or run initiates; on line-level cables, the label shall indicate the signal and signal source. Record all speaker cable identifiers on record drawings.
9. No acid core or other corrosive flux solder shall be used in this system.

10. Speaker cable conductor sizes listed are minimum requirements. Actual wire size required shall be determined by the Contractor to maintain a maximum of 10% voltage drop or 0.5 dB insertion loss on any speaker zone. Actual speaker cabling installed shall meet or exceed minimum conductor sizes listed. Basis of design paging speaker cable listed herein is provided to list the minimum criteria and performance requirements for paging speaker cable.
11. The polarity of all cabling shall remain consistent throughout the project, on all equipment.
12. Do not run unbalanced audio signals over cables longer than 10 feet. Contractor shall provide a shielded transformer-based converter at signal source to convert the unbalanced signal to a balanced signal.
13. The Contractor shall provide an isolation transformer for any balanced or unbalanced audio line that exhibits hum, EMI / RFI, power line noise, or ground loops.
14. Provide all system wiring between all components as shown on project documents, as directed by the manufacturer, and/or required for proper system operation and to provide specified system functionality.

D. Equipment:

1. All necessary devices, sub-components, accessories, and incidental materials required to provide a complete, turn-key paging system that provides specified performance and all required system features and functions listed herein and as further detailed on the drawings shall be provided and installed as part of a complete system.
2. All speakers shall be connected in proper polarity.
3. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tools recommended by the manufacturer for that purpose. Use caution to avoid stripping or damaging connectors, terminals, or equipment by over-tightening termination fasteners.
4. The conductor color code used in terminating system cabling at system equipment and devices shall remain consistent from device to device for each unique device type throughout the project.

E. Grounding Requirements:

1. Furnish and install a minimum #6 AWG bonding conductor from each overhead paging system head end component to the nearest wall-mounted telecommunications grounding busbar. Actual bonding conductor size determined by its installed length. Refer to Section 27 0526 for grounding and bonding conductor sizing criteria.
2. Audio cable shields for line level signals shall be connected to the metal equipment chassis at both ends of the cable. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.
3. Speaker cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground speaker cable shields at signal origin telecommunications room end only.

3.02 SYSTEM SETUP, PROGRAMMING, AND ADJUSTMENT

A. The Contractor shall provide all system balancing, tuning, and adjustment required as part of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments that may be required.

B. Paging system shall be adjusted to provide 85 measured at one (1) meter from each speaker when voice pages are made. Sound shall be clear, even, and undistorted and free of any hum, noise, or sonic anomalies. Where speakers are controlled via local volume controls, adjustments shall be made with the volume control set at 70

3.03 TESTING

A. The Contractor shall conduct all system testing as part of the requirements of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments or corrective action that may be required to provide a complete system that provides the specified performance and all required system features and functions listed herein and as further detailed on the drawings.

B. At a minimum, the installer shall perform the following inspections and tests of the installed overhead paging system:
   1. Verify that all features and functionality are operating properly.
   2. Verify that the system receives signal from all sources and routes those signals as specified.
   3. Verify that priority override hierarchy functions properly and according to the hierarchy specified.
   4. Verify that system output meets specified sound level at each speaker.

C. Document all test results and submit as part of final system documentation package.

END OF SECTION

SECTION 28 0500
BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.

B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make the portion of the security systems a finished and working system.

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Description of systems include but are not limited to the following:

1. Extension of existing electronic access control system
2. Fire detection and alarm.
3. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.
4. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
5. Firestopping of penetrations of fire-rated construction as described in Division 7.

1.03 OWNER FURNISHED PRODUCTS

A. Existing access control system managed by Owner security vendor Accurate Controls, Inc.

B. Video surveillance cameras and recording equipment provided by Owner’s security contractor. Scope of work is rough-in and data cabling only.

1.04 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.05 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.

2. "Electrical Contractor" shall also refer to the Contractor listed in Division 28 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
3. "Security Contractor" as referred to herein refers to the Contractors listed in Division 28 of this Specification.
4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.

C. General:

1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to security systems including back boxes, conduit, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.
2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.
4. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
    a. Lighting Fixtures
    b. Gravity Flow Piping, including Steam and Condensate
    c. Sheet Metal
    d. Electrical Busduct
    e. Sprinkler Piping and other Piping
    f. Conduit and Wireway
    g. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Responsible for Security Systems grounding and bonding.
3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."

3. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:
1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
d. Maintenance clearances and code-required dedicated space shall be included.
e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
a. Scale of drawings:
1) General plans: 1/4 Inch = 1 '-0" (minimum).
2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.
3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.
5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
    a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

B. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa’s Codes, Laws, Ordinances and other regulations having jurisdiction.
2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

C. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.

7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
   a. Factory Mutual
   b. Underwriters' Laboratories, Inc.

D. Examination of Drawings:
1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

E. Electronic Media/Files:
1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

F. Field Measurements:
1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
28 13 00	Electronic Access Control

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Division of work (e.g., plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor's review stamps
3. Composition:
   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:
    a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
    b. Unstamped submittals will be rejected.
    c. The Contractor's review shall include, but not be limited to, verification of the following:
        1) Only approved manufacturers are used.
        2) Addenda items have been incorporated.
        3) Catalog numbers and options match those specified.
        4) Performance data matches that specified.
        5) Electrical characteristics and loads match those specified.
        6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
        7) Dimensions and service clearances are suitable for the intended location.
        8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
        9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
    d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
    e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
    a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
    b. The Contractor shall clearly indicate the size, finish, material, etc.
    c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
    d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 28 XX XX.description.YYYYMMDD
    b. Transmittal file name: 28 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:
1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:
1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
    a. Material: Delivered cost of product with taxes paid.
    b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
    a. Overhead and profit.
    b. Bonds.
    c. Insurance.
    d. General Requirements: Itemize all requirements.

4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    a. Security systems:
        1) Surveillance
        2) Access control

D. Update Schedule of Values when:
1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.10 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.11 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
1. Firestopping, including mechanical firestop systems.

1.12 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.13 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.14 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.

B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.15 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.16 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.01 Refer to individual sections.

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 0533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.03 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 28 sections for further requirements.
2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.04 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
2. Refer to the end of Section 27 0500 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
2. Submitted bound copies of approved shop drawings.
3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to the project site; submit receipt to Architect/Engineer prior to final payment being approved.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div28.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.

E. Refer to the individual specification sections for minimum hours of instruction time for each system.

F. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.
2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 SYSTEM STARTING AND ADJUSTING

A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.08 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record actual routing of all conduits sized 2" or larger.

E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.09 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

END OF SECTION

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SECTION 28 1300
ELECTRONIC ACCESS CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Portal Devices

1.02 RELATED WORK

A. Section 08 7100 - Door Hardware

B. Section 11 1900 - Detention Security Equipment

C. Section 26 0533 - Conduits and Boxes

D. Section 27 0528 - Interior Communication Pathways

E. Section 28 0500 - Basic Electronic Safety and Security System Requirements.

F. Section 28 3100 - Fire Detection and Alarm Systems.

1.03 QUALITY ASSURANCE

A. Access Control Contractor:

a. System shall be provided by Owner security vendor Accurate Controls, Inc. Refer to "Suggested Matrix of Responsibility" for rough-in and power requirements by Electrical Contractor.

B. Material:

1. All material which is Contractor furnished shall be new, unused and free from defects.
2. Where more than one of any specified item of equipment or material is used, all such items shall be the same product from the same manufacturer.

1.04 REFERENCES

A. International Building Code

B. NFPA 70 - National Electrical Code.

C. UL 294 - Standard for Access Control Systems.

D. UL 1449 - Standard for Surge Protective Devices.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 28 0500.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.
2. All component options and accessories specific to this project.
3. Wiring requirements.

C. System Drawings: Project-specific system CAD drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where each controller will be located. This block diagram shall be provided in Adobe PDF.
2. Provide a schedule of all controllers and the doors/points each controller controls. This schedule shall be provided in Adobe PDF.

3. Provide schedules describing each system input location by an architecturally familiar reference, e.g., Door 312A. The architectural door schedule shall be used as the basis. These schedules shall be provided in Adobe PDF

D. Submit sample format of site specific programming guides to be used for system planning/programming conference with Owner. These guides shall be provided in Adobe PDF.

E. So that required Owner personnel are present at the planning/programming conference required in Part 3 of this section, submit meeting agenda for the conference a minimum of two weeks prior to the conference.

F. Submit detailed description of Owner training to be conducted at project end, including specific training times. Refer to Part 3 of this section for details.

G. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and Installing Contractor. Provide documentation of the training and other applicable certifications of the Contractor.

2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.

1.06 SYSTEM DESCRIPTION

A. This section describes the devices and cabling for an extension of an existing access control system. The terms "access control system" and "security management system", or SMS, may be used interchangeably herein.

B. The company, manufacturer, and product names used in this section are for identification purposes only. All trademarks and registered trademarks are the property of their respective owners.

C. Performance Statement: This section and the accompanying access control-specific design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required. The Contractor shall be responsible for determining quantities of materials required for a complete and operational system. Floor plan drawings and schedules have been developed to aid the Contractor in determining device quantities and installation locations, but, where discrepancies between floor plans and schedules arise, the greater number shall govern.

1.07 OWNER FURNISHED MATERIAL

A. Data circuit / internet service

B. Existing computer network equipment:

1. Routers

2. Switches

3. Wireless access points

4. Uninterruptible power supplies for Owner furnished products

C. Existing access control equipment:

1. SMS server and control panel(s)

2. SMS workstation(s)

1.08 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 28 0500.

B. Provide final system block diagram showing any deviations from shop drawing submittal.

C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.

D. Provide schedules documenting:
   1. Controller installation locations including specific door numbers being controlled.
   2. All terminal block wiring, including cable numbers.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance data manuals as described below.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 28 0500.

B. Manuals:
   1. Hardware Manual: The manual shall describe all equipment furnished including:
      a. General description and specifications.
      b. Installation and check out procedures.
      c. System and equipment layout and electrical schematics to the control board and field device level. For multiple devices wired identically, only one wiring diagram is required per door configuration, to be labeled "TYPICAL".
   2. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, cleaning, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.10 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.
   1. Inspections: The Contractor shall perform two minor inspections at six-month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
   2. Minor Inspections: These inspections shall include:
      a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
      b. Mechanical adjustments if required on any mechanical or electromechanical devices.
   3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:
      a. Clean all equipment, including exterior surfaces and accessible and serviceable interior surfaces.
      b. Perform diagnostics on all equipment.
      c. Check, test, and calibrate (if required) all sensors.
      d. Run all system software diagnostics and correct all diagnosed problems.

C. Operation: Upon the completion of any scheduled adjustments or repairs, Contractor shall verify operation of the SMS.

D. Records, Logs and Work Requests: Contractor shall keep records and logs of each task completed under and outside of warranty. These logs shall be maintained in Microsoft Word or Excel. The log shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, description of work performed, the amount and nature of the material used, and the time and date of commencement and completion of the work. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the SMS. The Contractor shall deliver a record of the work performed within three (3) business days after work is completed. Defective items that have been replaced shall be given to the Owner. Should the

replacement item be a temporary replacement until the removed item is repaired, Contractor shall retain possession of the defective item for repair and subsequent re-installation.

E. System Modifications: Modifications by the Contractor are allowed after system acceptance. Contractor shall make recommendations for system modification in writing to the Owner. No system modifications shall be made without prior, written approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Manuals, and other documentation affected. The Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

F. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - PRODUCTS

2.01 PORTAL DEVICES

A. Cable:

1. Composite cable is allowed, although sufficient conductors may not be available in composite cables for all portal configurations. Contractor shall be responsible for additional required cables beyond one composite cable to each portal to meet functional requirements of the system.
    a. Door Position Switch: 22 AWG, 2 conductor, stranded.
    b. Lock: Minimum 18 AWG, 4 conductor, stranded.
        1) Lock may require heavier gauge cable depending on door hardware solution power requirements. Contractor shall coordinate with detention equipment subcontractor for higher current devices and shall adjust the gauge of the lock cable accordingly.
    c. Auxiliary Devices: Refer to plans for requirements.

B. Locks and Door Hardware:

1. Electric/electronic locks shall be furnished and installed by the detention equipment subcontractor.
2. Contractor shall interface with and terminate cables to locks.
3. Contractor shall coordinate with detention equipment subcontractor for specified sequences of operation at the various portals.
4. Refer to architectural specifications 08 71 00 and 11 19 00, and/or the architectural door schedule.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.

C. Provide wiring and connection to all electrified locking hardware devices. Complete programming and testing of all electrified locking hardware devices.

D. Install all door alarm contacts in accordance with manufacturer's instructions either recessed in the door header or surface mounted as required. Provide wiring and connection to door alarm contact devices. Complete programming, adjustment and testing of all door alarm contacts.

E. Install, wire, configure, adjust, program and test all access control system equipment.

F. All low voltage access control cabling shall be routed and supported completely separate from any and all other telecommunications or other low voltage system cabling.

G. Electronic access control system cabling shall not be spliced.

H. Flexible conduit is not allowed except with prior approval. Refer to Section 26 0533 for conduit requirements. Refer to Section 27 0528 for cable hanger and support requirements.

I. Each cable shall be appropriately identified, as defined on the record documents, at each end's termination point using pressure sensitive label strips.

J. The conductor color code used in terminating system cabling at system devices shall remain consistent from device to device for each unique device type throughout the project.

K. Install and tighten all connectors in accordance with manufacturer's instructions using the appropriately designed tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, or equipment by over tightening termination fasteners.

L. Grounding and Bonding Requirements:

1. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the control panel end.

M. Coordinate installation of all devices with other trades and utilities in the vicinity.

N. Cabling shall be plenum rated when installed outside conduit in plenum ceilings.

3.02 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL) as suitable for purpose specified and indicated.

3.03 MANUFACTURER AND INTEGRATOR COMBINED FIELD SERVICES

A. Installation shall be performed by a factory-trained and certified Contractor.

B. The Contractor shall provide a comprehensive, site-specific customer planning guide for the system. The Contractor shall conduct conference(s) with the Owner prior to any installation to discuss the programming and configuration options of the system and the planning guide.

C. The Contractor shall include labor for all planning and all programming activities required to implement the Owner's access policies for each system point and each operator and administrator. Any software programmable access policy, within the bounds of the hardware specified, shall be included.

D. The SMS Installation Contractor shall be present at meetings to coordinate all door hardware requirements with the detention equipment subcontractor.

3.04 SYSTEM DOCUMENTATION

A. The following sections shall be provided in the system documentation:

1. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.

2. Refer to Part 1 for details.

3.05 SYSTEM ACCEPTANCE

A. The SMS vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components, software and functionality. The Contractor shall perform the tests and document all results under the supervision of the manufacturer's systems engineer.

B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

C. The system shall not be accepted until all requirements of system documentation and training have been completed.

END OF SECTION

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SECTION 28 2300
VIDEO SURVEILLANCE

(VIDEO SURVEILLANCE EQUIPMENT PROVIDED AND INSTALLED BY OWNER. SPECIFICATION PROVIDED AS REFERENCE ONLY.)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Network Video Management System (NVMS).

B. Video Storage Solution

C. Cameras and Accessories.

D. Cabling.

1.02 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 26 0513 - Wire and Cable

C. Section 27 1500 - Horizontal Cabling Requirements

D. Section 28 0500 - Basic Electronic Safety and Security System Requirements

E. Section 28 3100 - Fire Detection and Alarm Systems

1.03 QUALITY ASSURANCE

A. NVMS Software Developer (Manufacturer): The NVMS system shall be a single-source manufacturer such that the single manufacturer develops, supports, and warranties the NVMS software solution.

B. Integrator/Installer (Contractor): The Contractor must be a NVMS-certified installation, service, and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1.04 REFERENCES

A. NFPA 70 - National Electrical Code

B. Electronic Industries Association (EIA) Video Surveillance Equipment Standards

C. UL 2044 - Standard for Commercial Closed Circuit Television Equipment

D. UL 3044 - Standard for Safety for Surveillance Closed Circuit Television Equipment

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 28 0500.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents.
2. All component options and accessories specific to this project.
3. Electrical power consumption rating and voltage.
4. Heat generation for all power consuming devices.
5. All required wiring shall be identified.
6. Number of IP addresses that will be required from the Owner's Information Systems Department.
7. Statement of Acceptability of Designed Server:
    a. If the Contractor agrees that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution and meets the demand of the application, this shall be stated in writing and submitted as part of the shop drawing submittal.

b. If the Contractor does not agree that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution, Contractor shall itemize the quantity, technical specifications, and capacities of the servers required to support the functionality and device quantities required by the project drawings. Indicate the capacity utilization factor for each server.

c. Contractor's bid shall include any required changes in server(s) capacity.

8. Calculation for storage required using the criteria contained in the project drawings.

9. Calculation for required network bandwidth, including any latency restrictions.

10. Provide annual cost and all terms and conditions for the NVMS Software Maintenance Agreement. Include all additional costs and terms and conditions for any Annual Service Contracts provided by the Contractor for all services that are not included in the Software Maintenance Agreement.

C. System Drawings: Project-specific system CAD drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical cameras), the diagram may show one device and refer to the others as "typical" of the device shown.

D. Sample format of site specific programming guides to be used for system planning/programming conference with Owner.

E. Meeting agenda for planning/programming conference required in Part 3 of this specification.

F. Submit detailed description of Owner training to be conducted at project end, including specific training time.

G. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and installing contractor.

2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.

H. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 28 0500 for coordination drawing requirements.

1.06 SYSTEM DESCRIPTION

A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey, closed circuit television system.

B. Performance Statement: This specification section and the accompanying project drawings are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

C. Refer to the project drawings for model numbers for the Basis of Design for all equipment.

1.07 LICENSING REQUIREMENTS

A. All licenses required for system operation shall be included in the Contractor's bid. Licenses shall include, but not be limited to, server and workstation software, cameras, encoders/decoders, and any other licensing that is required by the manufacturer for operation of any system component.

1. Camera licenses shall be provided for all cameras listed on the drawings.

2. The Contractor shall fill out the NVMS Bid Inventory Form located herein and provide at the time of bid.

1.08 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 28 0500.

B. Provide final system block diagram showing any deviations from shop drawing submittal.

C. Provide statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

D. Provide final camera type and camera requirements schedules documenting all changes made during construction.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described below.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 28 0500.

B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the manufacturer for each piece of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

1. Hardware Manual: The manual shall describe all equipment furnished including:
    a. General description and specifications.
    b. Installation and check out procedures.
    c. System layout drawings and schematics.
    d. Alignment and calibration procedures.
2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper installation, testing, and operation. The manual shall include:
    a. Definition of terms and functions.
    b. System use and application software.
    c. Graphical user interface use.
    d. Reports generation.
3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
    a. Computers and peripherals.
    b. System startup and shutdown procedures.
    c. Use of system.
    d. Recovery and restart procedures.
    e. Use of report generator and generation of reports.
    f. Data entry.
    g. Operator commands.
    h. Alarm messages.
    i. System permissions functions and requirements.
4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.10 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: Perform one minor inspection six-months after Substantial Completion and one major inspection prior to the expiration of the warranty.
2. Minor Inspections: Inspections shall include:
    a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
    b. Mechanical adjustments if required on any mechanical or electromechanical devices.
    c. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.
3. Major Inspections: Inspections shall include all work described under paragraph Minor Inspections and the following work:
    a. Clean all equipment, including interior and exterior surfaces.
    b. Perform diagnostics on all equipment, including all system software diagnostics, and correct all diagnosed problems.
    c. Adjust all camera alignments that have become out of alignment from their documented position at Substantial Completion.
    d. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.
    e. All warrantable system deficiencies during the Major Inspection shall be remedied under warranty at no cost to the Owner.

C. Operation: Upon the performance of any scheduled adjustments or repairs, verify operation of the NVMS system.

D. Emergency Service: The Owner will initiate service calls when the NVMS system is not functioning properly. Qualified personnel shall be available to provide service within the distance defined above. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365.

E. Records and Logs: Keep records and logs of each task completed under warranty. The log shall contain all initial settings upon Substantial Completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the NVMS system.

F. Work Requests: Record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what must be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within five (5) days after work is accomplished.

G. System Modifications: Make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

H. Software: Provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with NVMS system operators, shall include training for the new changes/features enabled, and shall be incorporated into the operations and maintenance manuals, and software documentation.

I. Refer to the individual product sections for further warranty requirements of individual system components.

1.11 SOFTWARE MAINTENANCE AGREEMENT/ANNUAL SERVICE CONTRACT

A. Provide annual cost and all terms and conditions for the Software Maintenance Agreement (SMA) provided by the NVMS manufacturer and/or the Contractor.

B. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services. The cost and terms of the SMA ***may*** be used by the Owner for NVMS solution selection.

PART 2 - PRODUCTS

2.01 NETWORK VIDEO MANAGEMENT SYSTEM - GENERAL REQUIREMENTS

A. The network video management system (NVMS) shall be an enterprise-class client/server-based video security solution that provides management of digital video, audio and data across a TCP/IP network.

B. Provide a turnkey solution that includes furnishing, installation, and configuration of a separate IP network, complete with all required network electronics, switches, and other hardware.

C. ONVIF Compliance:

1. The NVMS system shall be ONVIF certified as an ONVIF Network Video Client.
2. Cameras shall be ONVIF certified as an ONVIF Network Transmitter unless specifically noted as an exception to this requirement in the project drawings.

D. The NVMS system shall be an "open system."

1. To meet this requirement, the NVMS must directly support cameras from a minimum of three (3) readily available camera manufacturers.
2. The three (3) camera manufacturers must have no corporate relationship to the NVMS manufacturer.
3. "Directly support" shall be defined as plug-n-play using drivers that are commercially available at the time of bid that utilize the ONVIF specification as the means of integration.
4. In addition to the requirement to support three (3) independent manufacturer's cameras, the NVMS may support an unlimited additional quantity of in-house or other proprietary cameras.
5. The open system shall not require proprietary storage solutions. It shall support third party storage solutions, including:
    a. Commercially available Direct Attached Storage (DAS) devices.
    b. Network Attached Storage (NAS) devices.
    c. Storage Area Networks (SAN) for ***primary*** or archival storage purposes. Primary support for SAN shall be defined as:
        1) The ability to directly record to SAN device without first recording to an NAS or DAS.
        2) The NVMS is provided with a user experience that makes the video recorded to the SAN transparent to the user. This shall be defined as:
            a) Full search, bookmarking, and other software features for finding, marking, locating, and identifying video are supported by the NVMS for video recorded to a SAN in an identical way to video that is recorded to an NAS or DAS.
            b) No loading of the video from the SAN into the NVMS shall be required.
            c) Full playback, windowing of camera video, archiving, and exporting is supported by the NVMS for video recorded to the SAN in an identical way as video recorded to an NAS or DAS.
6. The system must have a published API/SDK permitting third party integrations to the product without restrictions.
7. The NVMS shall support active directory using LDAP protocol.

E. The NVMS system shall consist of the following hardware/software components:
   1. Software:
      a. Server and client
      b. Recording services, archival services, and storage management
      c. Configuration tools
   2. System storage as specified on the project drawings.
   3. Cameras and related hardware as specified on the project drawings.
   4. Hardware: Servers, workstations, and miscellaneous hardware (keyboard, mouse, KVM) as specified on the projects drawings.
   5. Network electronics and related hardware and software as specified on the project drawings.

F. Video from any camera on the system (on the LAN, WAN or Internet) shall be capable of being viewed from single or multiple workstations simultaneously at any time, limited only by network bandwidth.

G. The NVMS shall support simultaneous displaying of live (30 fps) video of a minimum of 16 cameras while the video monitoring screen is configured in a 16-camera split configuration. In no case shall the frame rate of the camera be required to be restricted to less than 30 fps to display a 16-camera split view.

H. Simultaneous display and recording of every camera shall be supported with independent user-adjustable frame rates that can be set differently for the display stream and the recording stream. These independent settings shall be unique per camera.

I. The NVMS monitoring software shall support any combination of recorded and live video in any multiple camera split view, including viewing recorded video and live video from the same camera.

J. The NVMS shall support continuous recording and event-based recording simultaneously. This shall be capable of being set on a per camera basis.

K. Viewing of video (live and recorded) shall be possible from client software from any client hardware that is connected to the security LAN/WAN or Internet (through appropriate firewalls). In addition, system administration shall be permitted from remote client hardware.

2.02 NVMS MANUFACTURERS

A. Basis of Design:
   1. Pelco
   2. Preapproved Equal

2.03 NVMS SERVER REQUIREMENTS

A. The server shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 100/1000BaseT.

B. The server shall be provided by the NVMS system vendor.

C. The server(s) requirements have been calculated based on the NVMS Basis of Design manufacturer noted above. By submitting a bid, the Contractor acknowledges that the calculated server requirements listed here may not be sufficient for a listed alternate, acceptable manufacturer selected by the Contractor. The Contractor shall modify the calculated server requirements listed herein based on the calculated requirement of the chosen manufacturer. The server requirements for the basis of design are as follows:
   1. Server Quantity and Location: Refer to project drawings for quantity of servers required and their location.

D. All licensing shall be included in the Contractor's bid.

2.04 NVMS SYSTEM DETAILED REQUIREMENTS

A. Network Requirements: The NVMS shall support Ethernet 10/100 BaseT and Gigabit Ethernet.
   1. Network protocols shall be supported including TCP/IP, IPX, and UDP.
   2. The network interface shall allow remote access of the NVMS from anywhere on the end-user's LAN/WAN or Internet (behind firewall).

3. The system shall permit limiting of frame rate transmission to individual clients.
4. Both Multicast and Unicast shall be supported.
5. All transmission of system data shall be secured using Secure Socket Layer (SSL) security on the TCP/IP network.
6. Simple Network Management Protocol (SNMP) shall be supported.

B. Video Formats:

1. The NVMS shall support MJPEG, JPEG2000, MPEG-4, H.264 and H.265 compression formats.
2. The system shall support any single stream of bandwidth up to 90Mbit/sec at 30 fps at 4872 x 3248 resolution with no system performance degradation, assuming appropriate network bandwidth.
3. Video shall be recorded using a 256-bit encryption algorithm with authentication (watermarking) software suitable for evidentiary proceedings. The watermarking feature shall provide evidence of altered video.
    a. The video shall be watermarked with the authentication key/signature during recording of live video to the drive.
    b. A video player shall be provided with the NVMS system.
        1) The player shall have the ability to validate the authentication upon playback.
        2) This authentication shall provide the storage media name, camera name, video time, and user information.
        3) The authentication shall have the ability to be password protected.
4. Resolution:
    a. The camera resolution shall be user selectable on a per-camera basis. Selecting or changing resolution shall not require a restart of the application, server, or workstation.
    b. The system shall support the following resolutions:
        1) Megapixel Resolutions: SXGA (1280 x 1024: 1.3MP), SXGA + EXGA (1400 x 1050: 1.4 MP), UXGA (1600 x 1200: 1.9MP), WUXGA (1920 x 1200: 2.3MP), QXGA (2048 x 1536: 3.1MP), WQXGA (2560 x 1600: 4.1MP), QSXGA (2560 x 2048: 5.2MP), 3296 x 2472: 8MP, 4000 x 2672: 11MP, 4864 x 3248: 16MP, 6576 x 4384: 29MP.
            a) 16:9 and 4:3 formats shall be supported.
        2) HDTV Resolutions: 720p, 1080(i/p) in 16:9 format.

C. Workstation Client Software Requirements:

1. The client software for the NVMS shall run as an application on Windows 7, 10, or 11 64-bit. The client software shall not require a PC more robust than that defined above in the section entitled "NVMS CLIENT REQUIREMENTS." Should the workstation client software require a PC configuration more robust than that defined herein, the cost of upgrading the workstation hardware to the more robust requirement shall be paid by the Contractor.
2. The client software shall provide video signal detection and provide alerts whenever video is lost on any input channel.
3. Updates to the client software shall be capable of being pushed to all clients from the NVMS server.
4. The client software shall provide a graphical mapping feature. The graphical map shall accommodate the importation of CAD files, or custom development of floor plans or site plans to create a to-scale or not-to-scale graphical representation of the system layout including all cameras.
    a. Cameras located on the graphical map shall be "live," which is defined as the ability to click the camera in the graphical user interface (GUI) to see camera information and live video. The camera name shall be available to the user via a "mouse hovering" maneuver over the camera icon.

b. For site cameras, the graphical map shall consist of an overall site plan showing all exterior cameras. Buildings and other physical entities on the site shall be graphically represented.
   1) The buildings shown on the site plan shall visually indicate to the user that cameras are located inside that building's interior, if applicable.

c. The user shall be able to click a building that contains cameras to obtain a new graphical layout of that building. Once the building interior layout graphical map is on screen, interior cameras shall be represented by icons.

d. The user shall have the ability to navigate back to the main (previous) graphical map via a single-click graphical icon.

5. Camera Configuration:
   a. Each camera shall be configurable for a 32-alphanumeric character name.
   b. The system shall allow for the setup and adjustment of brightness, contrast, archiving, motion detection, and Pan/Tilt/Zoom on a per camera basis.
   c. The NVMS shall support a separate frame rate for recording and a separate frame rate for viewing for every camera input (assuming the camera provides two streams). These frame rates shall be capable of being independently set for each camera input.
   d. The NVMS shall support the PTZ control of analog NVMS cameras through the encoders.
   e. The compression algorithm formats MJPEG and MPEG4 shall be supported in the same system and shall be individually selectable on a per-camera basis.
   f. Each individual camera shall be capable of having individual camera settings that shall include (at a minimum):
      1) Continuous recording.
      2) Motion-based recording capability shall be provided including:
         a) Motion as determined by the NVMS software using:
         b) Motion as determined at the camera.
         c) Motion trigger by digital inputs from external trigger systems such as contact closures, alarm inputs, POS integration, etc.
         d) Motion triggers received by external trigger inputs shall be recorded by the event recording capabilities of the NVMS and identifiable on a timeline during playback and in reports.
      3) Alarm-initiated recording.
         a) When a camera enters alarm recording mode, the NVMS shall have the capability of changing to different camera settings for the recorded video during the duration of the alarm mode. The settings capable of being changed shall include the frame rate and the resolution. These setting changes shall be configurable in advance per camera by the User through the software GUI.
      4) Time-based recording on a preset schedule.
      5) Manual (user) activation of the start and stop of the recording process through the GUI.
         a) The NVMS software shall prevent any user from manually starting and stopping the recording of video based on that user's login credential.
      6) Defined pre-event and post-event recording buffers shall be provided for all non-continuous recording events.
      7) Each camera shall be capable of having unique storage retention settings.
   g. The NVMS shall support unidirectional audio recording utilizing the built-in audio recording capability of audio-equipped IP cameras.

D. Pan/Tilt/Zoom (PTZ) Control:
   1. The NVMS shall support PTZ control from any client, including remote and mobile clients.
   2. The following PTZ features shall be supported:
      a. Priority Levels
      b. Device Group Control
      c. PTZ Override (Lockout)
      d. Proportional PTZ Control
      e. Preset Lock via video screen
      f. Preset Tour

E. Video Archiving:
   1. The archiving feature shall be hardware independent, providing the ability to utilize commercial off-the-shelf mass storage devices as archived video destinations, including optical DVD, DAS, NAS, SAN, and other external storage drives.
   2. The archiving software shall provide the ability to manage and store video information from multiple recorded video locations to a central location.
   3. Each NVMS server shall have the ability to set its own unique archiving settings. Video shall automatically be archived based on user-defined "percentage full" settings. When the NVMS reaches the designated capacity threshold, video shall be automatically copied to the archive storage destination, and space on the source of the recorded video shall be released for overwrite by new video information using a first-in, first-out algorithm.
      a. Exception: Video marked or tagged by the user or by automated alarm inputs shall be retained by the archiving process despites its location in the first-in, first-out timeline.
   4. Regardless of the video's storage location (local or in the archive), the NVMS software shall automatically retrieve video associated with an event on demand by the user in response to a search, browse, or other retrieval action. The actual storage location of the video shall be transparent to the user.
      a. Exception: Video archived to removable media (e.g., removable hard drives or optical DVD) shall require prompting to the user to insert the appropriate media.
   5. Archiving shall be capable of being scheduled such that archiving will only run during certain hours defined by the Owner.
   6. The NVMS solution shall be permitted to utilize advanced algorithms for managing onboard storage such as reducing the frame rate of recorded video for the oldest video as an alternative to completely removing the video using a first-in, first-out algorithm. If this option exists in the NVMS software, it must have the following features:
      a. Ability of the Owner to completely disable the feature.
      b. Ability to set a minimum frame rate that the system will not exceed.
      c. Ability to set the feature on a per-camera basis.

F. The NVMS shall provide up to 10 different and independent programmable recording schedules.
   1. The schedules may be programmed to provide different record frame rates for day, night, and weekend periods, as well as holidays and exception days.
   2. Advanced task schedules may also be programmed that could specify allowed log-on times for user groups, when events may trigger alarms, and when data backups and archiving should occur.

G. The VMS shall support Dual Authorization logon. It shall function as follows:
   1. Dual Authorization user groups may be created.
   2. Logon pairs, consisting of any two normal user groups, may be assigned to each Dual Authorization user group.

3. A separate set of privileges and priorities can be assigned for each Dual Authorization user group.
4. For each user group assigned as part of a logon pair, it shall be configurable whether the group can:
    a. Log on either individually or as part of the logon pair.
    b. Log on only as part of the logon pair.
5. If a user that is part of logon pair logs on individually, then the user shall receive the privileges and priorities of the user's assigned user group. If the same user logs in as part of a logon pair, then the user shall receive the privileges and priorities assigned to the Dual Authorization group to which the pair is assigned.

H. The NVMS shall auto-discover cameras and encoders. Device detection shall support devices in different subnets.

I. The NVMS shall be designed in such a way that server downtime or loss of communication to the server does not affect the functionality of the recording services. Normal recording and motion recording shall continue during server downtime.,

2.05 NVMS RECORDING REQUIREMENTS

A. The NVMS shall provide management of the recording and playback of video, audio, and data (bookmarking, alarm data, etc.).

B. Refer to the project drawings for specific variables to be used on a per-camera basis for the purpose of calculating storage capacity and retention.
1. Total distributed storage requirements shall be determined based on a minimum of 30 days storage retention.
2. Cameras shall be assumed to be recording 24 hours per day, 7 days per week, 365 days per year. Specific per-camera assumptions stated on the drawings for percent motion shall be used in the storage calculation.
3. Compression shall be permitted to be used in the storage calculation. The compression algorithm (MPEG-4, H.264, etc.) shall be used on a per-camera basis. If the NVMS permits variable levels of compression intensity, the use of the "average" or "medium" level setting shall be used in the storage calculation unless otherwise noted.
4. The Contractor shall provide the complete storage analysis and calculation as a shop drawing.

C. Network Video Recorder (NVR) Hardware Platform:
1. The NVR shall be defined as a storage device for recording IP video streams from IP cameras or from analog cameras that have been encoded to IP. In both cases, the NVR shall record IP streams from cameras or encoders located anywhere on the IP network without being direct-cable connected to the NVR.
2. Refer to the project drawings for specific requirements, model numbers, and basis of design for the NVR.
3. NVR Configuration:
    a. The NVR shall contain one hard drive for the operating system and software, and all hard drive storage required to achieve the required storage retention.
    b. Provide with RAID 5 hard disk controller configuration for the video storage hard drives.
4. The NVMS shall provide a failover function where an NVR can be assigned as a backup to other NVRs. When an assigned NVR goes out of service, the failover NVR takes over the responsibilities of the failed NVR. When the primary NVR returns to service, the control shall be automatically transferred back to the primary NVR.
5. It shall be possible to assign a redundant NVR to every NVR for use in normal operation of all NVR(s) in the system. The redundant NVR shall record the same streams as the primary NVR. The redundant NVR shall have its own disk drives where it shall store the recorded data.

2.06 NVMS CABLING

A. Refer to Division 27 for all cabling requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.

C. Mount all cameras in the approximate locations shown on the drawings. Coordinate installation with other trades and utilities in the vicinity. Cameras containing fixed lenses, moved by more than 1'-0" from their location shown on the drawings, shall have a new lens calculation performed by the Contractor. Provide Architect/Engineer with results of lens calculation before proceeding with installation.

D. Coordinate with Owner's IT Department to acquire network connections as well as any network configuration information, such as IP numbers, that will be required to connect NVMS to Owner network (if applicable).

E. Provide all low voltage and +120 VAC power to all devices as required for proper system operation. Refer to Sections 26 05 33 and 26 05 13 for further requirements.

F. Cabling shall be plenum rated when installed outside of conduit in plenum ceilings.

3.02 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the project drawings.

C. It shall be the Contractor's responsibility to correct all inadequate picture quality issues prior to acceptance of the system.

3.03 MANUFACTURER'S FIELD SERVICES

A. Installation shall be performed by a factory-trained and certified Contractor.

1. Provide a comprehensive, site-specific customer planning guide for the system. Conduct a conference with the Owner prior to any installation to discuss the programming options of the system and the planning guide. The result of this planning guide shall be the determination of the system options for each device and for the software.

B. Include labor for all planning and all programming activities required to implement the Owner's operational preferences for each device and software. Any software programmable option, within the bounds of the capabilities of the hardware specified, shall be included.

C. Provide a complete, functional system as described by the project drawings. These responsibilities include:

1. Complete hardware setup, installation, wiring, and software configuration of the system, including all remote operator locations and all peripheral hardware.
2. Complete programming of all hardware and software options in accordance with the Owner's preferences as determined by the planning guide conference.
3. Programming of all custom graphic GUI screens including devices.
4. Complete system diagnostic verification.

D. Provide an authorized manufacturer representative to commission the system and ensure that facility-wide standards and project setup procedures are adhered to.

3.04 SYSTEM ACCEPTANCE

A. Submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components and software. Perform the tests and document all results under the supervision of the manufacturer's system engineer.

B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

3.05 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system.
2. Complete documentation of all programming and options.
3. Complete operating instructions for all hardware and software.

B. The following sections shall be provided in the system documentation:

1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
2. User Manual: A step-by-step guide and instructions detailing all system user functions.
3. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams, and schematic diagrams.

3.06 SYSTEM TRAINING

A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.

B. Provide two weeks advanced notice of training to the Owner.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. System Administrators: A course detailing the system functions and operations. Provide configuration training on all aspects of the system.
2. Users: Provide a detailed course outlining the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, and general overview of the report hardware.
3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.

E. Minimum on-site training times shall be:

1. System Administrators: Three (3) days.
2. Users: One (1) day.
3. GUI Editing: One (1) day.

NVMS Bid Inventory Form

Item	Cost/Other
Total fixed (lump sum cost) for the entire project:	
Itemize the total fixed lump sum cost as follows:	
Software cost for NVMS including all implementation services.	
Cost for all camera hardware and associated accessories.	
Itemize software cost for the following (show the math):	
Fixed, non-reoccurring flat base cost (if any)	
Fixed, non-reoccurring per-camera licensing fee (if any)	
Recurring flat base cost (if any - do NOT include optional software maintenance agreement costs)	
Recurring flat per-camera licensing fee (if any)	
Client workstation licensing fees (if any)	
Remote Client licensing fees (if any)	
Mobile Client licensing fees (if any)	
Itemize all other license fees not included above.	
Add all required and optional software maintenance agreement costs (do NOT include in bid cost).	
Acknowledge receipt of addenda by writing addendum number to the right.	_____ through _____ inclusive

Include below Server Acknowledgement Statement per Section 28 2300, Article 2.3, Paragraph D.
List below all separate software options, licensing or other monetary features that the Integrator interprets as not being requested by this RFP, but that are available from the NVMS manufacturer for purchase. Attach separate document if needed.

END OF SECTION

SECTION 28 3100
FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fire alarm and detection systems.

1.02 RELATED WORK

A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.03 QUALITY ASSURANCE

A. Manufacturer: Company specializing in smoke detection and fire alarm systems.

B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction.

C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

1.04 REFERENCES

A. ASME A17.1 - Safety Code for Elevators and Escalators

B. NFPA 20 - Standard for Centrifugal Fire Pumps

C. NFPA 70 - National Electrical Code (NEC)

D. NFPA 72 - National Fire Alarm and Signaling Code

E. NFPA 101 - Life Safety Code

F. UL 2017 - General Purpose Signaling Devices and Systems

G. UL 217 / 268 - Standard for Smoke Alarms / Smoke Detectors for Fire Alarm Systems

H. 2018 Fire Code

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500 and as noted below.

1. Failure to comply with all the following and all the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.

2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.

B. Provide product catalog data sheets as shop drawings.

1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.

2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.

3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.

C. Submit CAD Floor Plans as Shop Drawings:

1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.

2. Indicate the precise routing of notification appliance circuits under the provisions of circuit survivability. Refer to "Wiring" under Part 3 - Execution of this specification section for requirements.
3. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.

D. About all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.

E. Provide installation and maintenance manuals under provisions of Section 26 0500.

F. Submit manufacturer's certificate that system meets or exceeds specified requirements.

G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.

H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.

I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a NICET Certification of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

1.06 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.
   a. Smoke and heat detectors, manual pull stations, duct smoke detectors, monitor modules, control modules and relays.
   b. Notification Appliances: Speakers, speaker strobes, and strobes.
2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet minimum of one (1) set each and shall turn over to the Owner upon completion.
3. All spare parts shall be housed in metal cabinet labeled "Fire Alarm Spare Parts."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 0500.

B. Store and protect products under provisions of Section 26 0500.

1.08 REGULATORY REQUIREMENTS

A. System: UL or FM Global listed.

B. Conform to requirements of NFPA 101.

C. Conform to requirements of Americans with Disabilities Act (ADA).

D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

1.09 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.

C. Extending the Existing Fire Alarm System: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to extend the existing fire alarm system. This includes, but is not limited to, additional power supplies, initiating devices and circuits, signaling devices and circuits, monitoring devices and circuits, auxiliary control and related devices such as, door holders and their control, smoke damper control, fan shutdown, etc. The existing fire alarm system shall be extended such that the existing fire alarm system's functionality, integrity and annunciation shall be equivalent to pre-construction conditions, unless noted otherwise. The functionality and integrity shall be maintained during construction. The entire system shall be able to be completely reset from any single reset location point. The entire system shall be annunciated at any annunciation location.

D. Extending the Existing Simplex Grinnell Fire Alarm System: The existing control panel shall remain and shall be operational throughout construction. The system shall only be disabled to make new connections and to modify the programming. A fire watch shall be provided for all areas affected during outages. All system outages must be scheduled with the Owner at least one week prior. Individual devices may be disabled as needed based on construction activities to reduce the potential for false alarms, but all devices must be operational when the Contractor is not physically on site. New initiating devices may be connected to the existing signaling line circuits where capacity is available. Provide additional signaling line circuits as needed based on existing and new device quantity, including replacement of existing panel components. Provide new notification circuits to serve the new devices, including all necessary power supplies, amplifiers, batteries, and 120-volt input circuits. All new devices shall be programmed to provide the same sequence of operation as the existing devices of the same type, unless noted otherwise.

E. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.

F. In-Building Network: A complete fire alarm system network shall be provided. Provide quantity of control panels as indicated on the drawings. The network shall be a Style 7 token ring, peer-to-peer network. The network shall be characterized by simultaneous or sequential transmission, or both, and reception of multiple signals on a signaling line circuit or communication channel. The distributed intelligent characteristic of the network shall provide for all nodes independently making pertinent system decisions with no need for a central controller. Each node shall be capable of independent operation should loss of network communications occur. In no case shall read-only network annunciation be acceptable as the only networking function.

G. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.

H. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.

I. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.

J. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.

1.10 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 26 0500.

B. Include location of end-of-line devices.

C. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.

D. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.

1.11 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 26 0500.

B. Include operating instructions, and maintenance and repair procedures.

C. Include results of testing of all devices and functions.

D. Include manufacturer's representative's letter stating that system is operational.

E. Include the CAD floor plan drawings.

F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

1.12 DOCUMENT STORAGE CABINET

A. The cabinet shall have all fire alarm system documents, including record drawings, wiring diagrams, operation manuals, etc. A legend sheet permanently attached to the door shall contain system passwords and inspection logs. The enclosure shall also provide two (2) key ring holders for system keys and a location for a standard size business card with service contact information.

1. The cabinet will have, permanently and securely mounted inside, a digital flash memory device with a minimum of 4 GB of storage capacity and a standard USB B connector for uploading and downloading electronic versions of record documents and system programming information.

B. The final version of the system database program shall be stored within the cabinet.

1.13 WARRANTY

A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.

B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

1.14 ANNUAL INSPECTION/TESTING AND SERVICE CONTRACT

A. Provide cost to furnish service, inspect, and test all devices of the fire alarm system per the requirement of NFPA for one (1) year, starting one year after the Date of Substantial Completion. Submit written reports of inspection testing per NFPA 72, Chapter 14.

B. Provide an alternate cost for a complete inspection/testing and service/maintenance contract for the fire alarm system for one (1) year two (2) years, starting one year after the Date of Substantial Completion. Submit sample contract terms and conditions for review with shop drawings.

C. The Owner may enter into a contract directly with the vendor after shop drawing submittals. This specification is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Johnson Controls - Simplex

2.02 Fire Alarm Pathway Class and Survivability Level

A. Pathway Class:

1. Pathway Class A: Circuits capable of transmitting an alarm signal during an open or a non-simultaneous single ground fault on a circuit conductor wiring system. Wiring of outgoing and return conductors shall be physically separated by a minimum of 50 feet or by a 2-hour rated enclosure.

2. Pathway Class B: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.

3. Pathway Class: SLC for addressable devices with less than 50 devices can be Class A or B, and more than 50 devices shall be Class A.

B. Pathway Survivability Level:

1. Pathway Survivability Level 1: Circuits are protected by an automatic sprinkler system and installed in metal raceways.
2. Shared Pathway Designation Level 2: Provide physical segregation of all life safety and non-life safety data.

2.03 SIGNALING LINE CIRCUIT DEVICES

A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

B. Signal Line Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device type as follows:
      1) W = Weather Proof
      2) WG = Wire guard is required
      3) Candela Ratings:
         a) ## = 15 Candela, 30 Candela; 75 Candela; 110 Candela; 177 Candela
         b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.
   b. Sequence of operation as follows:
      1) D = HVAC Control
      2) DIPS = Dual Interlock Pre-Action System

C. FA-120; Smoke Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device types as follows:
      1) Blank = Photoelectric
      2) CO = Combination Smoke / Carbon Monoxide
      3) COH = Combination Smoke / Carbon Monoxide / Heat
      4) COS = Combination Smoke / Carbon Monoxide / Strobe
      5) H = Combination Smoke / Heat Detectors
2. (BLANK) Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
3. (CO) Combination Smoke / Carbon Monoxide:
   a. Multi-criteria sensor for photoelectrical smoke sensing and carbon monoxide (CO) detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
   b. The combined photoelectric smoke detection CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.
   c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.

d. The detector shall use only one address on the SLC.

e. CO sensor cartridge element shall be field replaceable.

4. (COH) Combination Smoke / Carbon Monoxide/Heat Detector:

a. Multi-criteria sensor for photoelectrical smoke sensing, heat and carbon monoxide (CO) detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.

b. The combined photoelectric smoke detection / heat / CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.

c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.

d. The detector shall use only one address on the SLC.

e. CO sensor cartridge element shall be field replaceable.

5. (COS) Combination Smoke / Carbon Monoxide/ Strobe Detector:

a. Multi-criteria sensor for photoelectrical smoke sensing, carbon monoxide (CO) detection, and 177 Candela strobe. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.

b. The combined photoelectric smoke detection / heat / CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.

c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.

d. The detector shall use only one address on the SLC.

e. CO sensor cartridge element shall be field replaceable.

6. (H) Combination Smoke / Heat Detector:

a. Multi-criteria sensor for photoelectrical smoke sensing and rate of rise heat detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.

b. The detector shall use only one address on the SLC

7. Each smoke detector shall connect directly to an SLC loop, unless listed as stand alone.

8. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.

9. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.

10. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.

11. A test means shall be provided to simulate an alarm condition.

12. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

D. FA-121; Gas Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.

a. Device types as follows:

1) CO = Carbon Monoxide

2. (CO) Analog Carbon Monoxide Type Sensor.

E. FA-122; Duct Smoke Detectors, Sampling Tube Type:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device types as follows:
      1) # = Equipment or system
   b. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
   c. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
   d. Provide a remote alarm LED indicator device (FA-241) or (FA-242) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

F. FA-140; Heat Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device types as follows:
      1) Blank = Combination Rate of Rise / Fixed Temp
      2) F = Fixed Temp
      3) RC = Rate Compensated
      4) X = Explosion Proof
2. (BLANK) Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
3. (F) 200°F fixed temperature. Provide a remote addressable monitor module to interface with addressable system as shown on the plans.
4. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
5. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.
6. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.
7. Provide a remote LED indicator device if detector is not visible from a floor-standing position.
8. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.
9. A test means shall be provided to simulate an alarm condition.
10. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

G. FA-160; Monitor Modules:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    a. Device types as follows:
        1) Blank = Refer to Plans
2. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor Option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
3. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
4. The module shall supply the required power to operate the monitored device(s).
5. The module shall provide address setting means using rotary decimal or DIP switches.

H. FA-161; Addressable Control Module:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation
    a. Device types as follows:
        1) Blank = Refer to Plans
        2) DH = Door Hold Open
        3) PD = Hold Open Override
2. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional child relay(s), as required, rated for the electrical load being controlled (Contractor to match voltage, amps, etc.).
3. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
4. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
5. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

I. FA-280; Isolation Module:

1. Provide fault isolation modules or isolator detector base capable of isolating and removing the fault from Class A or Class X addressable loop data circuits while allowing the remaining data loop to continue operation. Provide a minimum of two isolation modules or bases and between every 15 devices.

2.04 NOTIFICATION APPLIANCE DEVICES

A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

B. Notification Appliance Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    a. Device types as follows:
        1) W = Weather Proof
        2) WG = Wire guard is required

3) Candela Ratings:

a) ## = 15 Candela; 30 Candela; 75 Candela; 110 Candela; 177 Candela

b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.

C. Notification Device(s):

1. Wall Mounted: Red housing with white lettering or pictogram.
2. Ceiling Mounted: Red housing with white lettering or pictogram.

D. FA-200; Visual Alarm Devices:

1. Wall or ceiling mounted, refer to plans.
2. High intensity (Candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
3. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
4. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
5. (W) Weatherproof Visual Notification Device: High intensity strobe, square housing, 75 Candela rating, suitable for wet locations. Provide with weatherproof back box.
   a. Mounting: Semi-flush wall.
   b. Conduit shall not be exposed.

E. FA-210; Audio Horn Alarm Devices:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
2. Wall or ceiling mounted, refer to plans.
3. Sound Rating: 85 dB at 10 feet. Sound levels for alarm signals shall not exceed 120 dBA in the occupied area.
4. Device shall be capable of a high and low dB level setting. Unless noted otherwise, the device shall be set to the high setting at building completion.
5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

F. FA-211; Combination Audio Horn and Visual Alarm Device:

1. Wall or ceiling mounted, refer to plans.
2. Combine audio and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
3. (W) Weatherproof Audio/Visual Notification Device: Electronic horn with high intensity strobe, square housing, 75 Candela, suitable for wet locations. Provide with weatherproof back box.
   a. Mounting: Semi-flush wall.
   b. Conduit shall not be exposed.

2.05 NOTIFICATION APPLIANCE CIRCUIT PANEL (NAC)

A. As shown on the plans or as a Contractor's option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NAC on the shop drawing submittals.

B. Each NAC shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NAC provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.

C. Power for each NAC shall be from a local 120 VAC life safety circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NAC from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Coordinate panel and circuit number with the Architect/Engineer prior to installation.

D. NAC extender panels may be installed only in locations coordinated with the Architect/Engineer.

E. Mounting: Surface.

2.06 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

A. FA-260; Flow Switch:

1. (FA-260) Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
2. Provide a dedicated monitor switch for each sprinkler flow switch.

B. FA-261; Tamper / Monitor Switch:

1. (FA-261) Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
2. Tamper switches in the same room or system may be monitored by a single monitor switch when shown grouped on the plans.
3. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
4. Device types as follows:
    a. Blank = Refer to Plans
    b. PIV = Post Indicator Valve
5. (PIV) Post Indicator Valve. Connection to post indicator valve for sprinkler system supervisory notification. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC. Provide surge protection device as recommended by the fire alarm system manufacturer on line entering/leaving the facility.

2.07 WIRING

A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with the Electrical Code for power-limited fire alarm signal service.

B. Fire Alarm Cable:

1. Manufacturers:
    a. Comtran Corp.
    b. Helix/HiTemp Cables, Inc.
    c. Rockbestos-Suprenant Cable Corp.
    d. West Penn Wire/CDT.
    e. Radix.

PART 3 - EXECUTION

3.01 SEQUENCES OF FIRE ALARM OPERATION

A. General:

1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.
2. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:
   1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
   2. A local signal in the control panel shall sound.
   3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
   4. History storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
   5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
   6. Transmit the appropriate signal (supervisory, trouble, alarm) to the building automation system via addressable relays tied to contact monitors on the system.
   7. Audible alarms sequence shall match existing sequence

C. Visual Alarms Sequence:
   1. Visual alarm sequence shall match existing sequence.

D. Fire Protection Electric Sprinkler Bell Sequence:
   1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.

E. HVAC System Sequence:

F. Kitchen Hood Fire Suppression System Sequence:
   1. The fire alarm system shall utilize an addressable relay to de-energize the hood supply fan controller.
   2. The fire alarm system shall utilize an addressable monitor module to monitor the fire suppression system.

G. AHU and Mechanical Fan Shutdown Sequence:
   1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers and mechanical fans. Coordinate other requirements with HVAC installer.
   2. The fire alarm system shall directly shut down the AHU or mechanical fan through the local HVAC control device (i.e., variable frequency drive or motor starter).
   3. Where a facility has more than one AHU or mechanical fan, each shall be shutdown individually based on input from initiation devices in the area served by the unit or designated for each air distribution system.
   4. All AHUs and mechanical fans shall be shutdown simultaneously throughout the building.

3.02 INSTALLATION

A. Install system in accordance with manufacturer's instructions and referenced codes.

B. Devices:
   1. General:
      a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
      b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
      c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.

d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.

2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.

3. Protection of Fire Alarm System:

   a. A smoke detector shall be installed within the vicinity of the main fire alarm panel and every NAC extender panel per NFPA 72. A heat detector may be substituted when a smoke detector is not appropriate for the environment of installation.

4. Duct-type Analog Smoke Detectors:

   a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.

   b. All detectors shall be accessible.

   c. Duct-type detectors shall be installed according to the manufacturer's instructions.

5. In-Duct Analog Smoke Detectors:

   a. In-duct analog smoke detectors shall be installed in the duct where shown on the drawings and details. The devices shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.

   b. All detectors shall be accessible.

6. Addressable Relays and Monitor Modules:

   a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.

   b. All modules shall be mounted in or on a junction box in an accessible location.

   c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.

7. SLC Loop Isolation Modules:

   a. Isolation modules shall be installed to limit the number of addressable devices that are incapacitated by a circuit fault.

   b. Install all Isolation Modules within the fire alarm control panel, unless otherwise indicated on the drawings. Refer to the fire alarm riser diagram for requirements. Refer to the floor plans for areas served by separate isolation modules.

8. Notification Appliance Devices:

   a. Devices shall be located where shown on the drawings.

   b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.

   c. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high, they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.

C. Wiring:

1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
2. Wiring shall be installed in conduit.
3. Wiring shall be installed in conduit from device to above accessible ceilings. Exposed plenum-rated cable (FPLP) shall be used above accessible ceilings supported every 4 feet or run in cable trays (if applicable) maintaining a minimum of 5-inches clearance from all lighting ballasts. Fire alarm cabling shall not be installed in the same bridle rings or cable trays designated for the cabling of other systems.
4. All junction boxes with SLC and NAC circuits shall be identified on cover. Refer to Identification Section 26 0513 for color and identification requirements.
5. Partial evacuation or relocation of occupants is the standard operating procedure for this facility in the event of an alarm. Therefore, all notification appliance circuits (NAC), including circuits serving NAC extender panels and other network communication circuits, must be installed and protected in accordance with the "circuit survivability" requirements described in NFPA 72. Contractor shall maintain the following:
    a. NACs serving separate evacuation signaling zones shall be routed separately such that they are no less than 4 feet apart when run horizontally and 1 foot apart when run vertically. They may come simultaneously only within 10 feet of the control panel.
    b. NACs passing through other evacuation signaling zone(s) shall be installed in conduit and routed through the 2-hour fire-rated chase(s) or enclosure(s) identified on the drawings.
    c. NACs passing through other evacuation signaling zone(s) shall be Electrical Code classified CIC cable (Fire Alarm Circuit Integrity) installed in conduit. Provide CIC cable meeting UL requirements for 2-hour listing.
        1) The CIC cable system shall be installed in a conduit system meeting all requirements of its UL-listed installation system (conduit, boxes, connectors, etc.).
6. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 26 0513.
7. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
    a. Fire alarm temporal audible notification for all audio appliances.
    b. Synchronization of all visual devices where two or more devices are visible from the same location.
    c. Ability to silence audible alarm while maintaining visual device operation.
8. Notification Appliance Circuits shall not span floors.
9. Signal line circuits connecting devices shall not span floors or.
10. Signal line circuits connecting devices shall be provided with an isolation module at each floor separation or as otherwise shown on the drawings.
11. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

D. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.
   1. Power Branch Circuit Conductors: In accordance with Section 26 0553.
   2. Signaling Line Circuit: Overall red jacket with black and red conductors.
   3. DC Power Supply Circuit: Overall red jacket with violet and brown conductors.
   4. Notification Appliance Circuit: Overall red jacket with blue and white conductors.
   5. Door Release Circuit: Gray conductors.
   6. Central Station Trip Circuit: Orange conductors.
   7. Central Station Fire Alarm Loop: Black and white conductors.

E. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.

F. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

3.03 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 0500.

B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.

C. Contractor shall test and adjust the fire alarm system as follows:
   1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than or equal to the greatest of the following:
      a. 70dBA.
      b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
      c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
      d. As specified on the drawings.
   2. Sound level measurement procedure shall meet the following requirements:
      a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
      b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.
      c. All measurements shall be taken after fixed equipment (HVAC units, etc.) producing ambient noise is installed and is in operation.
      d. Final ambient sound measurements shall be taken during occupancy and the units shall be re-adjusted at that time, if necessary.
      e. All sound level measurements shall be taken at a height of 5' above the finished floor level.
      f. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of two (2) rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
      g. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
      h. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.

3.04 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services under provisions of Section 26 0500.

B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

C. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

D. Include the services to train up to three of the Owner's staff in operation, maintenance, and programming of the fire alarm system at the manufacturer's factory. Airfare and lodging expenses for the Owner's staff will be by the Owner.

E. System Occupancy Adjustments: When requested by Owner within 12 months of date of Substantial Completion, provide on-site system adjustments to suit actual occupied conditions. For this purpose, provide up to two (2) site visits, four (4) hours each visit, outside normal occupancy hours.

3.05 SYSTEM TRAINING

A. System training shall be performed under provisions of Section 26 0500.

B. Minimum on-site training times shall be:

1. System Operators: One (1) day.

END OF SECTION

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SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.02 SUMMARY:

A. This section includes the following:
   1. Protection of existing trees.
   2. Removal of Trees and other Vegetation.
   3. Clearing and Grubbing.
   4. Removing above-grade improvements.
   5. Removing below grade improvements.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 31 20 00 Earthwork

1.04 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specifications Section.

B. Schedule indicating proposed sequence of operations for selective demolition work to Owner's Representative for review prior to start of work.

1.05 PROJECT CONDITIONS:

A. Traffic: Conduct site demolition operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

B. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fencing to protect trees and vegetation as instructed on drawings.

C. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

D. Environmental Controls: Comply with governing regulations pertaining to environmental protection.
   1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

E. If unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure both nature and extent of conflict. Submit report to Owner's Representative, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.

F. Salvageable Improvements: Carefully remove items indicated to be salvaged, and store on owner's premises where indicated or directed.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 DEMOLITION:

A. General: Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
   1. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction.

3.02 SITE CLEARING:

A. General: Remove trees, shrubs, grass, and other vegetation, improvements or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated.
   1. Removal includes digging out and off-site disposing of stumps and roots.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.

B. Clearing and Grubbing: Clear sites of trees, shrubs and other vegetation, as indicated on the plans.
   1. Completely remove stumps, roots, and other debris protruding through ground surface.
   2. Use only hand methods for grubbing inside drip line of trees indicated to remain.
   3. Fill depressions caused by clearing and grubbing operations with satisfactory soil materials, unless further excavation of earthwork is indicated.
      a. Compact fill material in accordance with requirements of Section 31 20 00 Earthwork.

C. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated on drawings.

3.03 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove from site debris, rubbish, and other materials resulting from demolition operations. Transport and legally dispose of off-site.
   1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
   2. Burning of removed materials is not permitted on project site.

3.04 CLEAN UP AND REPAIR:

A. General: Upon completion of demolition work, remove tools, equipment, and demolished materials from site. Remove protections:
   1. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start of operations. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION

SECTION 31 20 00

EARTHWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work specified in this Section.

1.02 DESCRIPTION OF WORK:

A. Extent of Earthwork is indicated on Drawings.

B. Work includes:
1. Stripping, topsoil stockpiling.
2. Excavation.
3. Fill.
4. Compaction.
5. Preparation of subgrade for walls, parking and drives, and steps and walks.
6. Grading.
7. Topsoil placement.
8. Finish grading.
9. Erosion Control
10. Excludes: Over Excavation and Structural Backfill within building pad. Refer to Structural Specifications and Geotechnical Report.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Erosion Control: Section 31 35 00.

B. Site Clearing: Section 31 10 00.

C. Landscape Grading, Section 32 91 19.

1.04 QUALITY ASSURANCE:

A. Codes and Standards:
1. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
2. The entire installation shall fully comply with all local and state laws and ordinances, and with all established codes applicable thereto.

B. Testing and Inspection Service:
1. Cost of field and laboratory testing will be borne by the Owner. Testing by laboratory approved by the Owner and Engineer.
2. Contractor will cooperate with testing laboratory and geotechnical Engineer in coordinating compaction testing, installation and protection of settlement monitoring devices.

1.05 SUBMITTALS:

A. Testing Reports - Excavating: Submit the following reports directly to the Engineer from the testing services, with copies to the Contractor and the Owner.
1 Test reports on borrow material/lab analysis of fill materials.
2. Verification of each footing subgrade (material and unconfined compressive strength).

3. Field density test reports.
4. One optimum moisture-maximum density curve for each type of soil encountered.

Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.

1.06 JOB CONDITIONS:

A. Soil Borings:
1. Soil borings have been made for this site and can be found in Geotechnical Report prepared by TEAM Services (Report No. 1-5118), dated April 12th, 2022.
2. Test borings and other exploratory operations may be made by Contractor at no cost to Owner with Owner approval.

B. Existing Utilities:
1. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
2. Underground utilities shown on the drawings have been taken from existing public records, Owner's records and available as-built drawings and are correct to the best of our knowledge and provided for information only.
3. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities caused by Contractor to the satisfaction of utility owner at no cost to the Project Owner.
4. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
5. Provide minimum of 48-hour notice to Owner and Engineer and receive written notice to proceed before interrupting any utility.
6. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

C. Protection of Persons and Property:
1. Barricade open excavations occurring as part of this work and post with warning lights.
2. Operate warning lights as recommended by authorities having jurisdiction.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

D. Survey:
1. The topographic survey of the site is provided for informational purposes only. The contractor is responsible for verifying topography of the site prior to construction. No change orders or drawing revisions will be executed or issued for any contractor claims that the survey is wrong. This includes but isn't limited to frost heave or farming activity claims.

PART 2 PRODUCTS

2.01 SOIL MATERIALS/DEFINITIONS:

A. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups CL, ML, CL-ML, GC, GW, GP, GM, ML, SC, SM, SW, and SP.

B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups MH, CH, OL, OH, PT and any bedrock material.

C. Subbase material (granular fill): Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, natural or crushed sand.

D. Fill materials:
1. The fill material type shall be cohesive, soil having a "CL", “CL-ML” soil classification in accordance with the Unified Soil Classification System and shall have a maximum laboratory dry density (100%) of 100 pounds per cubic foot or more as determined by ASTM D698 (Standard Proctor).
2. No organic dark colored soils or plastic and potentially expansive soils, such as clay shale, are considered suitable engineered fill materials. Topsoils should be sorted and stockpiled for landscaping purposes. Topsoil materials can also be used for surcharge fill.
3. When fill material includes rock, the maximum rock size acceptable shall be three inches (3"). No large rocks shall be allowed to nest and all voids must be carefully filled with small stones or earth, properly compacted. No large rocks will be permitted within twelve inches (12") of the finished grade.

E. Topsoil: Secure and stockpile from naturally well drained areas during stripping operations; use satisfactory soil materials free of admixture of subsoil, reasonably free from clay lumps, stone or other debris a greater than 3/4" in diameter.
1. Should also comply with all NPDES and Iowa DNR requirements, if these requirements are more stringent that project specifications.

PART 3 EXECUTION

3.01 EXCAVATION:

A. Excavation is unclassified, and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

B. Unauthorized Excavation:
1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
2. Unauthorized excavation, as well as remedial work resulting from the unauthorized excavation directed by Engineer shall be at Contractor's expense.
3. Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

C. Additional Excavation:
1. When excavation has reached required subgrade elevations, notify Engineer who will make an inspection of conditions. Engineer shall evaluate and advise if bearing material is suitable and shall provide unconfined compressive strength tests.
2. If unsuitable bearing materials are encountered at required elevations, carry excavations deeper and replace excavated material with engineered compacted backfill as directed by engineer in soils/ geotechnical report.
3. Reference Geotechnical/ Soils Report for all possible over excavation.
4. No additional compensation will be provided for grading and pipe installation for the site work unless unsuitable soils are encountered which are not represented in the soils report.
5. It is the intent that if the contractor encounters unsuitable soils within the building envelope (foundation and slab) that the unit prices as seen in the front-end sections 01 22 00 shall apply.

D. Stability of Excavations:
1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction.
a. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

b. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

E. Dewatering:
1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
2. Do not allow water to accumulate in excavations.
3. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.
4. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
5. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas.
6. Do not use trench excavations as temporary drainage ditches.

F. Material Storage:
1. Stockpile satisfactory excavated materials where directed by Trade Contractor and SWPPP Inspector, until required for backfill or fill.
2. Place, grade and shape stockpiles for proper drainage.
3. Locate and retain soil materials away from edge of excavations.
4. Do not store within drip line of trees indicated to remain.
5. Dispose of excess soil material and waste materials as herein specified.

G. Subgrade Preparation: Paving systems (See Soils Report):
1. Provide a minimum 4” aggregate base for exterior pavements with material meeting the specifications for IDOT granular subbase (Section 4121)
2. Provide a minimum 12” compacted depth subgrade (2-6” lifts) for paving, plus fill as required.
3. Scarify, mix and recompact materials to provide uniform composition at least 12" below top of subgrade for paving for full width of subgrade plus 2'-0" on each side of paving.
4. Construct 12" thick uniform subgrade by excavating top 6" of subgrade, scarifying, mixing, and recompacting next 6" of subgrade and then replacing top 6" of subgrade and recompacting.
5. Proof roll existing soils prior to placing fill to determine location of unsuitable bearing materials. Notify Engineer if unsuitable conditions are encountered for direction. Proof roll truck requirements (axles, wheels and weight) per Iowa DOT specifications.
    a. Perform proof rolling with a truck loaded to the maximum tandem axle gross weight of 40,000 pounds. Operate trucks at less than 10 mph. Make multiple passes for every lane. The subgrade will be considered to be unstable if, under the operation of the loaded truck, the surface shows yielding (soil wave in front of the loaded tires), pumping or rutting of more than ½ inch, measured from the top to the bottom of the rut at the outside edges.
6. Compact as per Paragraph 3.02 Compaction requirements.

H. Topsoil Stripping
1. Strip and stockpile a minimum of the top 6” of soil on all disturbed areas. Additional depth of stripping may be necessary as stated in soils report. Final quantity of topsoil stripped shall be adequate to respreads a minimum of 8” in all green, non-paved areas.

3.02 COMPACTION:

A. General: Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated below.

B. Compaction Requirements: Compact top 12" of subgrade and each layer of backfill or fill material to not less than the following percentages of maximum density:

Construction Type	Standard Proctor ASTM D698 Cohesive Soils
Building, recreation field subgrade walls, roadway, parking lot and critical backfill area beneath same; e.g. trenches	95%
Backfill adjacent to structures not supporting other structures - minor subsidence possible.	95%
Lawn areas. Non-critical areas - moderate subsidence possible.	85-90%
Upper 12 inches of pavement subgrade.	98%
Within 3 feet below footing bearing level.	98%

*Use relative density technique (ASTM D4253 and D4254) where standard proctor technique (ASTM D698) does not result in a definable maximum dry density and optimum moisture content.

C. Moisture Control and Content:
1. When subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by disking, harrowing or pulverizing until moisture content is reduced to a satisfactory value.
4. The fill material shall be compacted at a moisture content typically within a range of optimum moisture content as determined by ASTM D698 (Standard Proctor). Report has varying moisture content ranges depending on plasticity.

3.03 BACKFILL AND FILL:

A. General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
1. In excavations, use satisfactory excavated or borrow material. Site strippings (per soils report) are not to be used as satisfactory excavated material.
2. Under grassed areas, use satisfactory excavated or borrow material.
3. Under walks and pavements, use subbase material or satisfactory scarified and recompacted subgrade or borrow material, or combination of these.
4. Under steps, use subbase material.

5. Under piping and conduit, use subbase material where subbase is indicated under piping or conduit; shape to fit bottom 90 degrees of cylinder.

B. Ground Surface Preparation:
1. Clearing area to be filled: All timber, logs, trees, brush and rubbish shall be removed or otherwise acceptably disposed of.
2. Scarifying area to be filled:
a. All vegetable matter and dark colored organic soil shall be removed from the surface upon which the fill is to be placed (per soils report) and the surface shall be plowed or scarified to a depth of at least 8 inches and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.
b. Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical, the bank shall be stepped or benched. Ground slopes which are flatter than 5 to 1 shall be benched when considered necessary by the Engineer.
3. Compaction area to be filled: After the foundation for the fill has been cleared and plowed or scarified, it shall be disked or bladed until it is uniform and free from large clods, brought to within the specified moisture content range and compacted to not less than ninety-five percent (95%) of maximum dry density in accordance with current ASTM D698 (Standard Proctor).

C. Placement and Compaction:
1. Depth and Mixing of Fill Layers: The selected fill material shall be placed in level, uniform layers which, when compacted, shall have a density conforming to a minimum of ninety-five percent (95%) of maximum dry density in accordance with ASTM D698 (Standard Proctor). Each layer shall be thoroughly blade mixed during the spreading to insure uniformity of material in each layer. Compacted layer thickness will be compatible with the demonstrated compatibility of the compaction equipment being used, with a compacted layer thickness of 6" considered typical.
2. Amount of Compaction: After each layer (lift) has been placed, mixed and spread evenly, it shall be thoroughly compacted to a minimum of ninety-eight percent (98%) of the material's maximum dry density as determined by ASTM D698 (Standard Proctor) for areas within 3 feet below building foundation. Grassed areas or areas not supporting buildings or slabs-on-grade should be compacted to a minimum of ninety-five percent (95%).
3. Compaction of Fill Layer: Compaction equipment shall be of such design to be able to compact the fill to the specified density. Compaction shall be accomplished while the fill material is within the specified moisture content range. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to ensure that the required density has been obtained.
4. Compaction of Slopes: Fill slopes shall be compacted. Compacting operations shall be continued until the slopes are stable but not too dense for planting on the slopes. Compacting of the slopes may be done progressively in increments of three to five feet (3' to 5') in fill height or after the fill is brought to its total height.
5. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

3.04 GRADING:

A. General:
1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
2. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grading Outside Paving Lines:

1. Grade areas to adjacent to paving lines to drain away from structures and to prevent ponding.
2. Finish surfaces free from irregular surface changes, and as follows:
   a. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.
   b. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10' above or below required subgrade elevation.

C. Grading Surface of Fill Under Paving & Recreational Fields (coordinate with field specs):
1. Grade smooth and even, free of voids, compacted as specified, and to required elevation.
2. Provide final grades within a tolerance of 1/2" when tested with a 10' straightedge.

D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.05 EMBANKMENTS:

A. General: Prepare site, place and compact excavated materials to required elevation and cross section.

B. Construction:
a. Construct embankment in horizontal layers not more than 8" in loose thickness.
b. Deposit each layer over full width of embankment as separate and distinct operation.
c. After layer is deposited, smooth to uniform depth by means of suitable motor patrol or bulldozer.
d. Compact layer by rolling with tamping type roller until full weight of roller is supported by tamping feet, but with not less than one pass per inch of loose thickness of layer.
e. Roller will be considered to be supported entirely on its tamping feet when feet do not penetrate more than 3" into material being compacted.
f. If soil is wet so that it will not sufficiently compact by one passing of roller per inch of loose thickness, provide one disking per 2" of loose thickness.
   a. Cut and stir full depth of layer.
   b. Allow interval of no longer than two hours between successive diskings, or as directed by Engineer.
   c. After disking is completed compact layer by specified rolling.
g. If soil is dry so that it will not satisfactorily compact by rolling, moisten material before compaction; manipulate material to secure proper distribution of moisture before compaction.
h. Whenever operations are suspended during periods rain is likely to occur, smooth and compact surface to shed water readily.
i. Compact to not less than 95% maximum dry density with moisture content not more than three percentage points above or below optimum; maximum density determined by ASTM D698 (Standard Procter). Different moisture ranges are possible for varying plasticity.

3.06 TOPSOIL SPREADING:

See Section 32 91 19 Landscape Grading.

3.07 FINISH GRADING:

See Section 32 91 19 Landscape Grading.

3.08 MAINTENANCE:

A. Protection of Graded Areas:
1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
2. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

3. Keep public streets clean from soil, soil tracking and debris at all times.

B. Reconditioning Compacted Areas: Where completed graded areas are disturbed by subsequent construction operations, erosion or adverse weather, scarify surface, re-shape and compact to required density prior to further construction.

C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.09 EROSION PROTECTION:

See Section 31 35 00 Erosion Control.

3.10 FIELD QUALITY CONTROL:

A. Quality Control Testing During Construction:
1. Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.
2. Perform field density tests in accordance with ASTM D2922 (nuclear method) or ASTM D1556 (sand cone method), as applicable.
3. Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test every 50 lineal feet to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.
4. Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 5000 sq. ft. of paved area, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 5000 sq. ft. of overlaying building slab or paved area, but in no case less than 3 tests.
5. If, in opinion of Engineer, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

3.11 NATURAL AND ARTIFICIAL DRAINAGE:

A. If necessary during the progress of the work to interrupt the natural drainage of the surface water, Contractor shall provide approved temporary drainage facilities.

B. If necessary to interrupt any field tile drains that might be encountered in this work, the Contractor shall restore or extend drains as necessary. Payment for this work will be on the basis of contract conditions relative to changes in work.

3.12 DISPOSAL OF EXCESS AND WASTE MATERIALS:

A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash and debris from site to an approved location, meeting state and local regulations, for disposal by Contractor.

B. All excess excavation shall be removed from the site unless otherwise stated on plans or directed by the owner.

END OF SECTION

SECTION 31 2005
EARTH MOVING FOR BUILDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Excavating and backfilling for buildings and structures.
2. Drainage course for building concrete slabs-on-grade.
3. Subsurface drainage backfill for walls.

1.03 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

1.04 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
B. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
C. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

E. Fill: Soil materials used to raise existing grades.
F. Structures: Buildings, footings, foundations, retaining walls, slabs, or other man-made stationary features constructed above or below the ground surface.
G. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

1.05 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Controlled low-strength material, including design mixture.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

1.06 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified are in place.

E. Do not commence earth-moving operations until plant-protection measures specified are in place.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Unsatisfactory Soils: Soil Classification Groups OL, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 0 and +4 percent of optimum moisture content for fine-grained soils and at levels satisfactory for compaction to be achieved without the coarse-grained material bulking during placement or pumping when proofrolled at course-grained soils.

C. Satisfactory Soils: Soil shall be free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Satisfactory Soils shall consist of the indicated soil classification groups according to the following locations:

1. Below Building Footings:

a. Low plasticity soil classification group CL with liquid limit less than or equal to 45 and a plasticity index less than or equal to 23.
b. Coarse-grained granular soil classification groups GW, GP, GM, GC, SW, SP, SM, SC.

2. Building Backfill:

a. Coarse-grained granular soil classification groups GW, GP, GM, GC, SW, SP, SM, SC.

3. Below building slabs and below drainage course:

a. Low plasticity soil classification group CL with liquid limit less than or equal to 45 and a plasticity index less than or equal to 23.
b. Coarse-grained granular soil classification groups GW, GP, GM, GC, SW, SP, SM, SC.

4. Below Slab Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and less than 6 percent passing a No. 200 sieve.

2.02 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:

1. Portland Cement: ASTM C 150/C 150M, Type I.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 33/C 33M, 1 1/2 inch nominal maximum aggregate size.
4. Water: ASTM C 94/C 94M.
5. Compressive Strength: 2000 psi.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXCAVATION, GENERAL

A. Excavation: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

3.04 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.05 EXCAVATION FOR SLABS ON GRADE

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.06 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.
B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.07 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2000 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.08 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.09 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
B. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 0 and +4 percent of optimum moisture.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 9 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

A. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Cohesive soils: 95% of maximum.
2. Granular soils:
    a. 98 percent of maximum according to ASTM D698.
    b. If the material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction to at least 70% relative density according to ASTM D4253 and D4254.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
    1. Provide a smooth transition between adjacent existing grades and new grades.
    2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
    1. Place drainage course 6 inches or less in compacted thickness in a single layer.
    2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
    3. Compact each layer of drainage course to required cross sections and thicknesses to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections
B. Inspections: Refer to Section 01 45 00 “Special Inspections and Tests” for required verifications and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
    1. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 3000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
    2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Relocate surplus satisfactory soil to a location on the Owner's property as directed by the Owner’s Representative.

B. Remove surplus unsatisfactory soil and waste materials, including trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Trench excavation for pipe systems, manholes, intakes and other structures.

B. Trench bedding and foundation stabilization.

C. Pipe and structure placement and backfill.

1.02 DESCRIPTION OF WORK

A. Perform all excavations required to complete the work shown on the plans.

B. Prepare trench excavations and shoring for new work, and install the utility lines, structures, and system components, including bedding and foundation stabilization.

C. Complete specified backfill operation.

D. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Results of Proctor and In-Place Density Tests on backfill.

C. Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store delivered materials and excavated materials in locations that will not interfere with operations and minimize environmental damage.

C. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.

D. Remove unsuitable and excess materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by Engineer.
2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on the plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

B. Conform to local, state, and federal requirements.

C. Abandoned Utilities: Remove and dispose of abandoned utility lines including gas mains, water mains, sewer mains, telephone conduits, service lines, etc. required to complete the work. Said work shall be incidental to the project unless otherwise specified.

PART 2 - PRODUCTS

2.01 EXCAVATED MATERIALS

A. Unclassified Excavation: Excavation of all materials encountered, except rock and over-excavation.

B. Rock Excavation: Boulders or sedimentary deposits that cannot be removed without continuous use of pneumatic tools or blasting.

C. Over-excavation: Excavation of soil or rock in trenches below the pipe zone.

D. Suitable Excavated Materials for Backfill:
1. Soil, clay, silt, sand, and gravel with moisture content suitable to achieve required compaction. ASTM D 2321, Class II through IVA (see 2.01, E).
2. Fine-grained soils according to ASTM D 2321 Class IVB (inorganic) (see 2.01, E) may be used in the final backfill upon approval of the Engineer.
3. Adjust moisture content of excessively wet, but otherwise acceptable, material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.
4. Adjust moisture content of excessively dry, but otherwise acceptable material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.
5. Lime or fly ash may be added to soils to produce a suitable backfill material. Uniformly mix soil and additive. Determine Standard Proctor maximum density and optimum moisture content of the modified material. Amount of additive applied is subject to Engineer's approval.

E. Non-Manufactured (Excavated) Backfill Materials: (See Sections 2.03 and 2.04 for manufactured backfill)

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	Pl	Uniformity C_u	Curvature C_c
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines	100 %	‹50% of "Course Fraction"	‹5%	Non-Plastic		›4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						‹4	‹1 or ›3
		SW	Well-graded sands and gravelly sands; little or no fines.		›50% of "Coarse Fraction"				›6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						‹6	‹1 or ›3
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines.	100 %	Varies	5% to 12%	Non-Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils, with Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100 %	‹50% of "Coarse Fraction"	12% to 50%		‹4 or ‹"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					‹7 and ›"A" Line		
		SM	Silty sands, sand-silt mixtures.		›50% of "Coarse Fraction"			›4 or ‹"A" Line		
		SC	Clayey sands, sand-clay mixtures.					›7 and ›"A" Line		
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100 %	100%	›50%	‹50	‹4 or ‹"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clay, lean clays.					›7 and ›"A" Line		

IVB (1)	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100 %	100%	›50%	›50	‹"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					›"A" Line		
V	Organic Soils (Unsuitable for backfill)	OL	Organic silts and organic silty clays of low plasticity.	100 %	100%	›50%	‹50	‹4 or ‹"A" Line		
		OH	Organic Clays of Medium to high plasticity, organic silts.				›50	‹"A" Line		
	Highly Organic (Unsuitable for backfill)	PT	Peat and other high organic soils.							

(1) See section 2.01, F, 2 for restrictive use.

F. Unsuitable Material: Remove unsuitable materials from the site, including, but not limited to, the following:
1. Rock with gradation not meeting the stated gradation for stabilization material.
2. Individual stones or concrete chunks larger than 3 inches, and averaging more than one per each cubic foot of soil.
3. Frozen materials.
4. Stumps, logs, branches, and brush.
5. Trash, metal, or construction waste.
6. Soil in clumps or clods larger than 6 inches, and without sufficient fine materials to fill voids during placement.
7. Unsuitable soils, as defined in Section 2010, 2.03, excluding material used as topsoil.
8. Class V Material (ASTM D 2321), as defined in Section 3010, 2.08.
9. Environmentally-contaminated soils.

G. Replacement of Unsuitable Soils:
1. If the excavated material is determined by the Engineer to be unsuitable and cannot be conditioned so that it becomes suitable, furnish all necessary backfill material.
2. Remove and dispose of unsuitable material from the site.

2.02 STABILIZATION (FOUNDATION) MATERIALS

A. Clean 2-1/2 inch crushed stone or crushed portland cement concrete (PCC) material, with the following gradation:

Sieve	Percent Passing
2-1/2"	100
2"	90 to 100
1-1/2"	35 to 70
1"	0 to 15
1/2"	0 to 5

B. Engineer may authorize a change in gradation subject to materials available locally at time of construction. Subject to the Engineer's approval, crushed concrete may be used if it is within plus or minus 5% of the gradation for each size of material.

2.03 CLASS I GRANULAR BEDDING AND BACKFILL MATERIAL (Storm Sewers and Sanitary Sewers)

A. Use gravel or crushed stone for granular bedding, complying with the following gradation:

Sieve	Percent Passing
1-1/2"	100
1"	95 to 100
1/2"	25 to 60
No. 4	0 to 10
No. 8	0 to 5

Note: Engineer may authorize the use of crushed PCC, for pipe sizes up to 12 inches, or a change in gradation subject to materials available locally at time of construction.

B. Compaction: See Section 3.06.

2.04 CLASS II BACKFILL MATERIAL (Storm Sewers, Sanitary Sewers, and Water Mains)

A. Class II material is manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse-grained natural soils (clean) with little or no fines.

B. Class II material is non-plastic soil less than 1-1/2 inches in size and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	Where hydraulic gradient exists check gradation to minimize migration. Clean groups suitable for use as drainage blanket and underdrain.
GP	Poorly graded gravels and gravel sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	
SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	
SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	

C. Compaction: See Section 3.06.

D. Class II material may be specified in the contract documents by the Engineer between the pipe embedment zone and the top 2 feet of final backfill when the trench is under the pavement.

2.05 CLASS III BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer, and Water Mains)

A. Class III material is natural coarse-grained soils with fines.

B. Class III material follows Section 2.01, G and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.	Do not use where water condition in trench may cause instability.
GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.	
SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.	
SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.	

C. Compaction: See Section 3.06.

2.06 CLASS IVA BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer, and Water Mains)

A. Class IVA material is natural fine grained inorganic soils.

B. Class IVA material follows Section 2.01, G and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
ML	Inorganic silts, very fine sands, rockflous, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.	Obtain geotechnical evaluation of proposed material. May not be suitable under deep fills, surface applied wheel loads, and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.	

C. Compaction: See Section 3010, 3.06.

D. Suitable only in dry trench conditions.

2.07 CLASS IVB BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer and Water Mains)

A. Class IVB material is natural fine-grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%.

B. Class IVB material follows Section 3010, 2.01 and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.	Not to be used in pipe embedment zone.
CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.	

C. Compaction: See Section 3.06.

D. When approved by the Engineer, Class IVB material may be used as final trench backfill in a dry trench.

E. Do not use in the pipe embedment zone.

2.08 CLASS V BACKFILL MATERIAL (Topsoil)

A. Class V Material is natural highly organic soils with a liquid limit greater than 50%. See Section 2.01.

B. Use Class V Material only as topsoil outside of the pavement, unless otherwise specified or allowed by the Engineer.

C. Do not use Class V Material in the pipe embedment zone.

2.09 BEDDING AND BACKFILL MATERIALS FOR PIPE CULVERTS

A. Bedding:
1. Use minimum Type C embedment.
2. Install water stop or curtain wall at culvert inlet, as specified in the contract documents.

B. Backfill Material:
1. Use all suitable material excavated for pipe culvert work, as specified in Section 2.01, for backfill material.
2. Dry suitable material that has excessive moisture prior to placement.
3. Remove unsuitable material, as specified in Section 2.01, from the project site.

2.10 BEDDING AND BACKFILL MATERIALS FOR SUBDRAINS

A. Drainable Bedding and Backfill Materials Include:
1. Porous backfill material.
2. Pea gravel.
3. Use as shown on the plans or on the detailed drawings.

B. Porous Backfill Material:
1. Crushed stone or gravel with the following gradation:

Sieve	Percent Passing
3/4"	100
1/2"	95 to 100
3/8"	50 to 100
No. 4	10 to 50
No. 8	0 to 8

Iowa DOT Gradation No. 29.

C. Coarse Aggregate: Use Stabilization Materials, per Section 3010.

D. Pea Gravel: Use commercially available pea gravel.

E. Impervious Bedding: Use least permeable on-site materials.

F. Engineering Fabric: Use Iowa DOT 4196.

2.11 SPECIAL PIPE EMBEDMENT MATERIAL

A. Concrete Supports: Where specified in the contract documents, construct concrete support systems.

B. Concrete Bedding, Arch, or Encasement:
1. Concrete: commercial, 4,000 psi compressive strength.
2. Unreinforced, unless otherwise shown on the plans.
3. Minimum concrete thickness: 6 inches or as shown on the plans.

C. Flowable Mortar:
1. Approximate quantities per cubic yard:
   a. Cement 100 pounds
   b. Fly ash 300 pounds
   c. Fine aggregate 2,600 pounds
   d. Water, approximate 70 gallons
2. Compressive strength at 28 days; 100 psi to 200 psi.

D. Controlled Low Strength Material (CLSM):
1. Approximate quantities per cubic yard:
   a. Cement 50 pounds
   b. Fly ash 250 pounds
   c. Fine aggregate 2910 pounds
   d. Water, approximate 60 gallons
2. Compressive strength at 28 days 50 psi.

PART 3 - EXECUTION

3.01 PREPARATION

A. When natural soils for Class II, III, and IV backfill material is required as specified in Figure 3010.1, provide written certification from a testing laboratory that the material meets the class specified if so requested by the Engineer.

B. Locate, mark, and protect existing utilities and facilities in the work area.

C. Provide access to utility service locations, such as valves, manholes, and utility poles.

D. Identify owners of utilities on or near the site, and notify them of operations to occur.

E. Protect existing facilities and landscaping features, or replace as shown on the plans.

F. Protect bench marks, control points and land survey monumentation, or replace at Contractor's expense.

3.02 TRENCH EXCAVATION

A. Notify the Engineer prior to the start of excavation activities.

B. Remove and stockpile a minimum of 6” of topsoil for subsequent reuse.

C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

D. Remove rock, rubbish, boulders, debris, and other unsuitable materials at least 6 inches below, and on each side of the pipe. Restore grade using soil suitable for backfill.

E. Correct unauthorized excavation at no cost to Owner, using bedding or stabilization materials.

F. Provide protective fences and barricades around open excavations, appropriate to the surrounding area.

G. Provide weight tickets for stabilization material to the Engineer at the time of delivery.

H. Provide safety fence around open excavations.

I. Trench Excavation for Sanitary Sewers, Storm Sewers, Water Mains, and Pipe Culverts:
   1. Maximum and minimum pipe trench width: Min.=Pipe Dia.+1.5’; Max.=1.25*Pipe Dia. or 54”, whichever is greater.
   2. Flat trench bottom, conduit bearing directly on trench bottom (not applicable for rock excavation) for water main pipe only with bell hole shaping:
      a. Shape trench bottom to support pipe around 1/4 of perimeter for the full length of the pipe barrel.
      b. Provide bell holes.
   3. Trench bottom, conduit supported by bedding material:
      a. Excavate trench as shown on the detailed drawings.
      b. Install bedding material to support the full length of the pipe barrel.
   4. Trench depth:
      a. Flow Line plus Pipe Dia/8, or 4” min.
   5. Conform all trench operations to current OSHA regulations.

J. Structure Excavation:
   1. For concrete structures and parts of structures without footings, 18 inches outside the horizontal projection of the structure.
   2. For concrete structures with footings, 18 inches outside the footings.
   3. For anchor rods, 12 inches on each side of the rod.
   4. For buried anchors, the face of the buried anchor on one side and 24 inches outside the buried anchor on the other face.

3.03 ROCK OR UNSTABLE SOILS IN TRENCH BOTTOM

A. Notify the Engineer prior to over-excavation.

B. Engineer will determine the need for trench bottom stabilization prior to installation of pipes and structures.

C. See Figure 3010.1 for over-excavation of rock and wet or soft foundations.

D. Provide weight tickets for the stabilization material to the Engineer at the time of delivery.

3.04 SHEETING, SHORING, AND BRACING

A. Conform sheeting and bracing of all excavations to the latest state and federal regulations governing safety of workers in the construction industry.

B. Leave in place all temporary sheeting below 2 feet over top of pipe unless sheeting removal plan is approved by Engineer. Conform all trench operations to current OSHA regulations.

C. Move trench boxes carefully to avoid excavated wall displacement or damage.

D. When necessary or required, install adequate sheeting and bracing to prevent ground movement that may cause damage or settlement to adjacent structures, pipelines, and utilities.

E. Any damage due to settlement because of failure to use sheeting or because of inadequate bracing, or through negligence or fault of the Contractor in any other manner, shall be repaired at the Contractor's expense.

F. For sides of trenches in unsuitable, loose, or soft material, shore, sheet, brace, slope, or otherwise support by means of sufficient strength to protect employees working within them.

G. Where excavations are made with vertical sides that require supporting, use sufficient strength for sheeting and bracing to sustain the sides of the excavations and to prevent movement that could in any way injure the work or adjacent structures, or diminish the working space sufficiently to delay the work.

H. Select sheeting and bracing material of sufficient dimensions and strength to adequately support the sides of trenches and excavations, which will not split when driving and will be free of imperfections that may impair its strength or durability.

I. Drive sheeting to true alignment and ensure contact of adjacent pieces.

J. In wet excavation, use grooved sheeting to prevent passage of soil. Fill any voids between sheeting and face of excavation with suitable material.

K. Do not remove sheeting and bracing before the completion of the work, unless otherwise directed by the Engineer.

L. For sheeting left in place, cut off 18 inches for clearance below the bottom of the pavement in streets/highways and 18 inches below the original ground surface, unless otherwise required by the contract documents or the Engineer. Leave in place all temporary sheeting below 2 feet over top of pipe, unless a sheeting removal plan is approved by Engineer.

3.05 DEWATERING

A. Do all work in dry conditions; do not install pipes on excessively wet soil.

B. Perform the dewatering operation according to the dewatering plan submitted to the Engineer. Dewatering operations may be modified from the plan for actual field conditions, with approval of the Engineer.

C. Adequate dewatering is the Contractor's responsibility unless otherwise stated in the contract documents.

D. Install dewatering system appropriate for the soil conditions.

E. Maintain water levels sufficiently below the bottom of trench excavation, (typically 2 feet) to prevent upward seepage.

F. Provide for handling water encountered during construction:
1. Prevent surface water from flowing into excavation. Remove water as it accumulates.
2. Do not use sanitary sewers for disposal of trench water. Discharging water into storm sewers requires Engineer's approval.
3. Do not discharge water onto adjacent property.
4. Maintain and control water discharge as necessary to prevent a safety hazard for vehicular and pedestrian traffic.
5. Direct water discharge away from electrical facilities or equipment and intersections.
6. Use noise and fume reducing dewatering equipment to minimize disturbance.
7. Provide at least two operating pumps for each trench opened in wet ground, and at the same time have one pump in reserve.

G. Place backfill in trenches prior to stopping dewatering operations.

H. Protect trench water discharge points from erosion.

I. Operate dewatering systems to prevent damage to adjoining structures and facilities.

J. Monitor adjoining structures and facilities during dewatering operations. Cease dewatering operations and notify the Engineer if damage is observed.

3.06 PIPE INSTALLATION

A. Pipe Bedding:
1. Shape pipe bed to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe.
2. Install pipe and system components.
3. Place bedding simultaneously on both sides of the pipe. Correct any pipe displacements before proceeding.
4. Place bedding in lifts no greater than 6 inches thick and consolidate.
5. Concrete encasement: Install where shown on the plans.
6. If required in the contract documents or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other bedding material types.
7. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

B. Haunch Support:
1. Place granular haunch material in lifts no greater than 6 inches thick and consolidate by slicing with a shovel or using other approved techniques.
2. If required in the contract documents, or if approved by the Engineer, concrete, flowable mortar, or controlled low strength material may be used instead of other haunch material types. Secure pipe against displacement or flotation prior to placing flowable mortar, controlled low strength material, or concrete encasement.

C. Primary and Secondary Backfill (Pipe Cover):
1. Place pipe cover material in 6-inch lifts and compact to densities required according to class of material.
2. If required in the contract documents or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other cover material types. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.
3. Special pipe support: If required, provide special pipe support as shown on the plans.

D. Final Trench Backfill:

1. Place backfill in the trench immediately after recording locations of connections and appurtenances or at Engineer's direction.
2. Place backfill adjacent to structures immediately after concrete has reached design strength and connecting work has been completed.
3. Allow no more than 100 feet of trench to be open overnight or when work is not in progress except as provided on the plans.
4. Place suitable excavated backfill:
   a. Carefully place backfill over top of pipe and around structures.
   b. Compact as required.
5. Compaction:
   a. Within street right-of-way and under pavement, compact each lift to at least 95% of maximum Standard Proctor Density, otherwise compact to at least 90%.
   b. In areas more than 3 feet below pavement structure, place backfill in lifts no thicker than 8 inches.
   c. In areas less than 3 feet below pavement structure, place backfill in lifts no thicker than 6 inches. Terminate backfill at 8 inches below finish grade in areas to remain unpaved, and to subgrade elevation in areas to be paved. Place 8 inches of topsoil in unpaved areas.
   d. When crossing under levees, railroads, and State or Federal highways, comply with the compaction requirements of these jurisdictions, if more stringent than these requirements.
   e. For Vitrified Clay Pipe (VCP), keep all heavy compaction equipment 5 feet above the top of the pipe. In the area less than 5 feet, use hand held compactors. Do not allow the compactor to come in contact with the pipe.
6. Moisture Range: Obtain required compaction within a soil moisture range of minus two percent to plus four percent (-2% to +4%) of optimum moisture content as determined by ASTM D698 (Standard Proctor).
7. Dispose of surplus and unsuitable materials unless otherwise directed by owner.
8. Hydraulic compaction is not allowed unless authorized by the Engineer.

3.07 PIPE INSTALLATION IN CONSTRUCTED EMBANKMENTS

A. Install all pipes in trenches according to Section 3.06. When allowed by the contract documents, pipes may be constructed in embankments as follows:

B. Placing Backfill for Pipes:
1. Thoroughly tamp backfill under and around the pipe and in layers not to exceed 8 inches for the full length and width of the pipe.
2. Place backfill and thoroughly tamp around and over the pipe for its full length.
3. Extend the completed embankment on both sides of the pipe from the original ground line to at least 1 foot above the top of the pipe with a slope as shown in the contract documents. Construct the embankment over the pipe with a width no less than the outside diameter of the pipe and centered over the pipe. If necessary to accommodate construction traffic, increase the height of fill to the nominal diameter of the pipe or 3 feet, whichever is greater.
4. When pipe are laid wholly or partly in a trench, granular backfill material may be required for backfill. Compact the remainder of the fill to at least 1 foot above the top of the pipe with slopes as outlined above.
5. If the trench has been cut wide enough to permit use of a roller, after the pipe is bedded, thoroughly tamp the backfill material under and alongside the pipe with a mechanical tamper to the mid-height elevation of the pipe.
6. The contract documents may require placement of pipe with moisture control. When not required, place roadway pipe after construction of an embankment by methods that will produce results equivalent to those required for construction of the embankment, except that moisture determinations will be waived for placing backfill completed within 48 hours after excavation.
7. In addition to the normal backfill material requirements, when directed by the Engineer, build such approach fills to provide a roadway 10 feet in width over the pipe with grades no steeper than 10%.

3.08 STRUCTURE BEDDING

A. Bedding for Structures Bearing on Undisturbed Soils:
   1. Shape the bottom to accurate grade and size.
   2. Remove loose material, large clods, stones, and foreign materials.
   3. In unstable soils or rock conditions, see Section 3.03 for stabilization requirements.

B. Bedding for Structures Bearing on Bedding Material:
   1. Over excavate to minimum of 8 inches or as specified in the contract documents.
   2. Place bedding material for structures according to the contract documents. A

3.09 STRUCTURE BACKFILL

A. Removal of Forms and Falsework: See Section 6010, 3.06.

B. Placement of Backfill: Place backfill after structure concrete has reached at least 80% of the design strength and connecting work has been completed, unless otherwise specified. Determine strengths under comparable conditions. If strength is not determined, place backfill after 14 days.

C. Backfill Against Walls and Around Structures:
   1. Where backfill is required on both sides of a concrete wall and around all sides of monolithic structures, proceed with filling operations simultaneously on all sides of walls and structures so the fill is kept at approximately the same elevation at all times. Consider concrete box, arch, and circular culvert monolithic structures.
   2. Compact the 3 feet closest to all walls or wing faces by pneumatic or hand tampers only.

D. Placing Backfill with Excavated Material:
   Unless otherwise specified, see Section 3.06, D for suitable excavated materials for backfill.

3.10 OPEN CUT CASING PIPE INSTALLATION

A. Casing Pipe: Install casing pipe according to Section 3.01 to 3.07, as appropriate.

3.11 TRACER SYSTEM

A. Tracer wire shall be provided on <u>all</u> site utilities, including but not limited to:

   1. Telecommunication/copper.
   2. Empty conduits.
   3. Storm
   4. Sanitary.
   5. Gas.
   6. Water.
   7. Exceptions:
      a Straight storm runs with daylight each end do not require tracer wire).
      b Underground electrical lines do not require tracer wire.

B. Tracer wire: Solid, AWG #12, blue insulated, direct bury, Type TWHN. Install in trench attached directly to, parallel with, and centered above or below the utility.

C. Underground splices: Use Scotchcast splicing kits, 3M Company or approved equal.

D. Engineer shall provide specific details for tracer wire termination at each condition. Avoid receptacle boxes on posts in lawn areas (Install receptacle boxes on face of building or in flush ground boxes).

E. Test tracer wire for continuity after installation (see comment under “Specifications - Project Close-Out” above); All tracer wire which fails continuity testing shall be repaired or replaced as required until passing continuity testing. Provide Owner 48-hour notice of this activity.

F. In addition to tracer wire, Contractor shall install underground pipe markers: bright colored continuously printed plastic ribbon tape, 6” wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item. Install 8” to 10” below grade directly above buried utilities.

3.12 FIELD QUALITY CONTROL

A. References:
1. ASTM C 136; Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D 698; Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Moisture Using 5.5-pound (4.54 kg) Rammer and 12-inch (305 mm) Drop. (Standard Proctor Method)
3. ASTM D 1556; Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D 2216; Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
5. ASTM D 2922 and D 3017; Test Methods for Density of Soil and Soil-Aggregate in Place and Water Content of Soil and Rock by Nuclear Methods (Shallow Depth).
6. ASTM D 4253 and D 4254, Test Methods for Maximum Index Density of Soils using a Vibratory Table and Minimum Index Density of Soils and Calculation of Relative Density.

B. Compaction Testing: Compaction testing of backfill, cooperate and coordinate with an independent testing laboratory selected by the Owner. Cost of initial compaction testing will be paid for by the Owner. Cost of retesting of failed test areas shall be paid for by the Contractor. Refer to Section 014000, 1.5, Test and Inspection Services, and this Section 3.12, G. below for additional requirements.

C. Schedule Testing: Notify the Owner’s Representative and the independent testing laboratory when work is prepared for testing.

D. Soil Testing:

1. Cohesive soils: Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of cohesive soil used.

2. Cohesive soils: Determine in-place density and moisture content using ASTM D 1556 (sand-cone method) and D 2216 or ASTM D 2922 and D 3017 (nuclear).

3. Non-cohesive soils: Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and D 4254 (cohesionless soils).

4. Gradation: Test according to ASTM C 136.

E. Testing Frequency and Locations**:** Perform testing of the final trench backfill, beginning at a depth of 2 feet above the top of the pipe, as follows:
1. Contractor provided:
   a. Make one test per each 2 vertical feet of consolidated fill at each street crossing.
   b. Make one test per each 2 vertical feet of consolidated fill for each 200 horizontal feet of trench.
   c. Additional testing may be required by Engineer if non-compliance or a change in conditions occur.
   d. Coordinate the timing of testing with the Engineer.
   e. The Engineer will determine the location of testing.
   f. If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests. Place backfill and recompact.
2. Owner provided:

a. Coordinate the timing of testing with the Engineer.
b. The Engineer will determine the location of testing.
c. Test frequency will not exceed one test per each 2 vertical feet of consolidated fill for each 200 horizontal feet of trench.

F. Test Failure: Rework, recompact, and retest as necessary until specific compaction is achieved in all areas of the trench.

G. Retesting: In event of failed tests, rework the failed area and retest. Costs of such retesting shall be paid by the Contractor, at no additional cost to the owner.

END OF SECTION

SECTION 31 35 00

EROSION AND SEDIMENT CONTROL

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. NPDES General Permit No. 2

B. Stormwater Pollution Prevention Plan (SWPPP)

C. Erosion Control Measures

D. Velocity and Flow Control Measures

E. Sediment Control Measures

F. Application/Installation of Measures

G. Removal/Replacement of Measures

1.02 DESCRIPTION OF WORK

A. Furnish all materials; install, construct, maintain, and remove specified erosion control devices; at locations specified in the contract documents, or where specified by the Engineer, Owner and City.

B. Complete the required construction work on this project, while minimizing soil erosion and controlling water pollution. Maintain these features as specified, from initial construction stages to final completion of the project.

1.03 SUBMITTALS

Comply with Division 1 -General Provisions and Covenants, as well as the following:

Upon request, provide copies of all records and documentation related to compliance with the Iowa DNR NPDES Permit.

1.04 SUBSTITUTIONS

Comply with Division 1 -General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 -General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 -General Provisions and Covenants, as well as the following:

A. Implement erosion and sediment control measures at the appropriate time(s).

B. Coordinate construction to minimize damage to erosion and sediment control devices.

1.07 SPECIAL REQUIREMENTS

A. Permit:

1. When applicable, comply with the requirements of the Iowa Department of Natural Resources, *NPDES (National Pollutant Discharge Elimination System) General Permit No. 2 for Stormwater Discharge Associated with Industrial Activity for Construction Activities*, and the Stormwater Pollution Prevention Plan.

2. For projects covered under the Iowa DNR General Permit No. 2, sign on as a co-permittee with the owner and any other contractors or subcontractors.

3. When applicable, comply with the local jurisdiction's permitting requirements.

B. Protection of Property: Prevent accumulation of soil, sediment, or debris from project site onto adjoining public or private property. Remove any accumulation of soil or debris immediately, and take remedial actions for prevention.

Protect Existing Facilities At The Site Against Damage Including The Following:

1. The Contractor shall take precautions to ensure that equipment, vehicles, and construction operations do not disturb or damage existing grades, walls, drives, pavement, utilities, plants, lawns, and other facilities.

2. Verify locations and depths of all underground utilities prior to excavation and report any conflicts with new work to the Engineer.

3. Any damage to existing trees or shrubs branches and root systems to remain and be protected shall be repaired and/or pruned by an experienced arborist.

4. Repair, replace, and/or return to original condition any damaged item, without additional compensation.

C. Permit Compliance: When applicable, conduct all operations in compliance with the Iowa DNR NPDES General Permit No. 2. Labor, equipment, or materials not included as a bid item, but necessary to prevent stormwater contamination from construction related sources, are considered incidental. Incidental work related to compliance with the permit may include, but is not limited to: hazardous materials protection, fuel containment, waste disposal, and providing employee sanitary facilities.

D. Project Staging: Replacing erosion and sediment control practices that are damaged or removed by the contractor in a manner that is inconsistent with the current project staging or SWPPP is the Contractor's responsibility and will be at the Contractor's expense.

PART 2 -PRODUCTS

2.01 COMPOST BLANKETS

Comply with Section 32 92 19, Seeding, 2.07, C for compost material requirements for compost blankets.

2.02 COMPOST BLANKET AND FILTER BERM TACKIFIER

A. Use a biodegradable, organic binding agent or polyacrylamide that can be mixed with, or injected into, compost or filter material as it is placed, which is not detrimental to the establishment of vegetation.

B. Use in filter berms or compost blankets when specified in the contract documents.

C. Apply at the rate recommended by the manufacturer.

2.03 FILTER MATERIAL

Material for use in filter socks, filter berms, and other areas, as specified in the contract documents.

A. Use material derived from wood, bark, or other, non-toxic vegetative feedstocks.

B. Use material with no visible admixture of refuse or other physical contaminants, nor any material toxic to plant growth.

C. Use material meeting the following particle sizes:

Sieve Size	Percent Passing1
2”	100
1”	90-100
3/8”	0-30

[1]The target flow rate of in-place material is 10 gal/min/lf. The Engineer may approve use of alternate materials meeting the target flow rate.

2.04 FILTER SOCK

A. For slope and sediment control applications, use a continuous, tubular, knitted, mesh netting with 3/8 inch openings, constructed of 5 mil thickness, photodegradable HDPE.

B. For inlet protection, use a continuous, tubular, knitted, mesh netting with 3/8 inch openings, constructed of 500 denier polypropylene.

C. Use 1 inch by 2 inch (minimum) hardwood stakes or stakes of equivalent strength.

2.05 TEMPORARY ROLLED EROSION CONTROL PRODUCTS (RECP)

Use temporary rolled erosion control products that are classified and have material properties according to the Erosion Control Technology Council’s (ECTC) guidelines as follows:

A. Material Classification:

1. RECP Type 1 (Ultra Short-term): Functional longevity of 3 months or less and classified as follows:

a. RECP Type 1.A: Mulch control net, consisting of a photodegradable synthetic mesh or woven biodegradable natural fiber netting.

b. RECP Type 1.B: Netless rolled erosion control blankets, consisting of natural and/or polymer fibers,

mechanically interlocked and/or chemically adhered together to form a RECP.

c. RECP Type 1.C: Single-net erosion control blankets and open weave textiles, consisting of processed degradable natural and/or polymer fibers, mechanically bound together by a single rapidly-degrading, synthetic or natural fiber netting, or an open weave textile of processed rapidly-degrading natural or polymer yarns or twines woven into a continuous matrix.

d. RECP Type 1.D: Double-net erosion control blankets, consisting of processed degradable natural and/or polymer fibers, mechanically bound together between two rapidly-degrading, synthetic or natural fiber nettings.

2. RECP Type 2 (Short-term): Functional longevity between 3 and 12 months and classified as follows:

a. RECP Type 2.A: Mulch control net, consisting of a photodegradable synthetic mesh or woven biodegradable natural fiber netting.

b. RECP Type 2.B: Netless rolled erosion control blankets, consisting of natural and/or polymer fibers, mechanically interlocked and/or chemically adhered together to form a RECP.

c. RECP Type 2.C: Single-net erosion control blankets and open weave textiles, consisting of an erosion control blanket composed of processed degradable natural or polymer fibers, mechanically bound together by a single degradable synthetic or natural fiber netting to form a continuous matrix, or an open weave textile composed of processed degradable natural or polymer yarns or twines woven into a continuous matrix.

d. RECP Type 2.D: Double-net erosion control blanket, consisting of processed degradable natural and/or polymer fibers, mechanically bound together between two degradable synthetic or natural fiber nettings.

3. RECP Type 3 (Extended Term): Functional longevity between 12 and 24 months and classified as follows:

a. RECP Type 3.A: Mulch control nets, consisting of a slow-degrading synthetic mesh or woven natural fiber netting.

b. RECP Type 3.B: Erosion control blankets and open weave textiles, consisting of processed slow-degrading natural or polymer fibers, mechanically bound together between two slow-degrading synthetic or natural fiber nettings to form a continuous matrix, or an open weave textile composed of processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix.

4. RECP Type 4 (Long Term): Functional longevity of 36 months and classified as follows: Erosion control blankets and open weave textiles, consisting of processed slow-degrading natural or polymer fibers, mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix, or an open weave textile composed of processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix.

B. Properties and Performance:

1. Testing performed according to the ECTC's Testing Procedures for Rolled Erosion Control Products. Verify manufacturer's test results by independent testing.
2. Material properties meeting the Erosion Control Technology Council's (ECTC) Standard Specifications for Rolled Erosion Control Products as follows:

*Product tested according to ECTC Test Method No. 2 and meeting the ECTC Standard Specifications for "C" factor.

C. RECP Anchors: Stakes or staples as recommended by manufacturer, with a minimum length of 6 inches.

2.06 WATTLES

A. Netting: Open weave, degradable netting. Nominal diameter of 9 inches, or as specified.

B. Fill Material: Straw, wood excelsior, coir, or other natural materials approved by the Engineer.

C. Stakes: 1 inch by 1 inch (minimum) wooden stakes, or stakes of equivalent strength.

2.07 CHECK DAMS

A. Synthetic Permeable Check Dam (HDPE):

1. Ditch Berm:
a. Installed height of 9 to10 inches.
b. Manufactured check dam constructed from sheets of perforated, UV-stabilized High-Density Polyethylene (HDPE).

c.

Classification	Slope Application	Channel Application	Min. Tensile Strength
	Max. Grade*	Permissible Shear Stress	
RECP Type 1.A	5:1 (H:V)	0.25 lb/ft2	5 lb/ft
RECP Type 1.B	4:1 (H:V)	0.50 lb/ft2	5 lb/ft
RECP Type 1.C	3:1 (H:V)	1.50 lb/ft2	50 lb/ft
RECP Type 1.D	2:1 (H:V)	1.75 lb/ft2	75 lb/ft
RECP Type 2.A	5:1 (H:V)	0.25 lb/ft2	5 lb/ft
RECP Type 2.B	4:1 (H:V)	0.50 lb/ft2	5 lb/ft
RECP Type 2.C	3:1 (H:V)	1.50 lb/ft2	50 lb/ft
RECP Type 2.D	2:1 (H:V)	1.75 lb/ft2	75 lb/ft
RECP Type 3.A	5:1 (H:V)	0.25 lb/ft2	25 lb/ft
RECP Type 3.B	1.5:1 (H:V)	2.00 lb/ft2	100 lb/ft
RECP Type 4	1:1 (H:V)	2.25 lb/ft2	125 lb/ft

Perforations of 30 to 40% open area.

2. RECP for Permeable Check Dam (when specified): RECP Type 4, 4 feet wide.

3. Anchors: As recommended by the manufacturer.

B. Triangular Foam Check Dam: Triangular-shaped device with a height of 8 to 10 inches and a base of 16 to 20 inches.

1. Inner Support Material: Urethane foam.

2. Outer Cover: Woven geotextile material shaped to fit around the inner support material, extending 2 to 3 feet beyond the bottom edge of the triangular-shaped inner support.

3. Length: 7 feet.

C. Rock Check Dam:

1. Aggregate: Erosion stone complying with Iowa DOT Article 4130.04.

2. Engineering Fabric: Comply with Section 2.20.

2.08 LEVEL SPREADERS

A. Provide 2 inch by 8-inch (minimum) pressure-treated timber of the length specified.

B. Use timbers that are relatively straight and have a minimum length of 5 feet each.

2.09 RIP RAP

A. Class A Revetment: Comply with Iowa DOT Section 4130.

B. Class B Revetment: Comply with Iowa DOT Section 4130.

C. Class D and E Revetment: Comply with Iowa DOT Section 4130.

D. Erosion Stone: Comply with Iowa DOT Section 4130.

2.10 TEMPORARY PIPE SLOPE DRAINS

A. PVC, HDPE, and metal pipes as specified in Section 33 40 00, Storm Sewer, 2.01.

B. HDPE, Type C (corrugated interior).

C. All pipes listed are allowed for use within the right-of-way.

2.11 SEDIMENT BASIN OUTLET STRUCTURES

A. Base: Class C concrete unless otherwise specified in the contract documents.

B. Riser: CMP complying with Section 33 40 00, Storm Sewer; diameter as specified in the contract documents.

C. Dewatering Device:

1. Drill holes in the riser of the number, diameter, and at the elevation specified in the contract documents.

2. 1/4 inch by 1/4 inch or 1/2 inch by 1/2 inch wire mesh for hardware cloth.

D. Barrel: CMP complying with Section 33 40 00, Storm Sewer; diameter as specified in the contract documents.

E. Anti-Vortex Device: CMP complying with Section 33 40 00, Storm Sewer; diameter and riser diameter as specified in the contract documents.

F. Anti-Seep Collar: Corrugated metal sheet of same material and gage as barrel section.

Size according to plans.

2.12 SEDIMENT TRAPS

A. Erosion Stone: Comply with Section 2.09

B. Engineering Fabric: Comply with Section 2.20.

2.13 SILT FENCE

A. Fabric: Comply with Iowa DOT Article 4196.01.

B. Posts: 4 foot minimum steel (T-section) weighing at least 1.25 pounds per foot, exclusive of anchor plate. Painted posts are not required.

C. Fastener: Wire or plastic ties with a minimum tensile strength of 50 pounds.

2.14 STABILIZED CONSTRUCTION ENTRANCE

A. Entrance Stone: Comply with Iowa DOT Section 4122, Gradation 13, Macadam crushed stone.

B. Subgrade Stabilization Material: Use woven, UV-stabilized geotextile with a minimum tensile strength of 135 lb/ft.

2.15 DUST CONTROL

A. Water: Use potable water or water from a source approved by the engineer.

B. Calcium Chloride: Comply with Iowa DOT Article 4194.01.

C. (Not Used)

D. Soapstock (Soybean Oil):

1. Use a commercially-available, undiluted, soybean oil soapstock emulsion.

2. Comply with manufacturer's recommendations for storage, transportation, temperature, and application equipment requirements.

2.16 EROSION CONTROL MULCH

A. Conventional Mulch:

1. Use dry cereal straw (oats, wheat, barley, or rye) or native grass straw.

2. Use material that is free of noxious weeds, seed-bearing stalks, or roots, and will be inspected and approved by the Engineer prior to use.

3. Other materials, subject to the approval of the Engineer, may be used.

B. Hydromulch:

1. Wood Cellulose Mulch:

a. Use material that is a natural or cooked cellulose fiber processed from whole wood chips, or a combination of up to 50% of cellulose fiber produced from whole wood chips, recycled fiber from sawdust, or recycled paper (by volume).

b. Product contains a colloidal polysaccharide tackifier adhered to the fiber to prevent separation during shipment and avoid chemical co-agglomeration during mixing.
c. Form a homogeneous slurry of material, tackifier, and water.

d. Use a slurry that can be applied with standard hydraulic mulching equipment.

e. Dye the slurry green to facilitate visual metering during application.

f. Do not use materials that have growth or germination-inhibiting factors or any toxic effect on plant or animal life when combined with seed or fertilizer.

2. Bonded Fiber Matrix (BFM):

a. Produced from long-strand wood fibers, held together by organic tackifiers and bonding agents that, when dry, become insoluble and non-dispersible.

b. Upon curing 24 to 48 hours, form a continuous, 100% coverage, flexible, absorbent, erosion-resistant blanket that encourages seed germination.

c. Manufactured to be applied hydraulically.

d. Physical Properties:
1) Fibers: Virgin wood, greater than 88% of total volume.
2) Organic Material: Greater than 96% of total volume.
3) Tackifier: 8-10%.
4) pH: 4.8 minimum.
5) Moisture Content: 12% +/- 3%.
6) Water-holding Capacity: 1.2 gal/lb.

e. Dyed green to facilitate visual metering.

3. Mechanically Bonded Fiber Matrix (MBFM): See Section 32 92 19, Seeding.

a. Produced from long-strand wood fibers and crimped, interlocking synthetic fibers.\

b. Within two hours of application, form a continuous, 100% coverage, flexible, absorbent, porous, erosion-resistant blanket that encourages seed germination.

c. Manufactured to be applied hydraulically.

d. Physical Properties:
1) Wood Fibers: 73% minimum.
2) Tackifier: 10% +/- 1%.
3) Crimped, Interlocking Synthetic Fibers: 5% +/- 1%.
4) Moisture Content: 12% +/- 3%.
5) Water holding capacity: 1.2 gal/lb.
6) Minimum pH: 4.8.

e. Dyed green to facilitate visual metering.

2.17 TURF REINFORCEMENT MATS (TRM)

A. Material Classification:

1. TRM Type 1: Use a TRM that is constructed of a web of mechanically or melt-bonded polymer netting, monofilaments, or fibers that are entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, or the placement of synthetic fibers between two high-strength, biaxially-oriented nets, mechanically bound by parallel stitching with polyolefin thread. Products may contain a degradable component.

2. TRM Type 2 and 3: Use a TRM that is constructed of a web of mechanically or melt-bonded polymer netting, monofilaments, or fibers that are entangled or woven to form a strong and dimensionally stable mat. Non-woven bonding methods include polymer welding, thermal or polymer fusion, or the placement of fibers between two high-strength, biaxially oriented nets, mechanically bound by parallel stitching with polyolefin thread. Use only components that are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

3. TRM Type 4: Use a high performance/survivability TRM that is composed of monofilament yarns woven into a resilient uniform configuration. Use a mat that has a matrix that exhibits very high interlock and reinforcement capacities with both soil and root systems and demonstrate a high tensile modulus. TRMs manufactured from discontinuous or loosely held together by stitched or glued, netting, or composites are not allowed in this category. Use only components that are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. Use this category when field conditions exist with high loading and/or high survivability requirements.

B. Properties and Performance: Meet the minimum material and performance requirements contained in the following table:

Property1		**Test Method**	**Type 1**	**Type 2**	**Type 3**	**Type 4**
Material	Thickness	ASTM D 6525	0.25 in	0.25 in	0.25 in	0.25 in
	Tensile Strength2	ASTM D 6818	125 lb/ft	240 lb/ft	750 lb/ft	3,000 lb/ft
	UV Resistance3	ASTM D 4355	80% @ 500 hrs	80% @ 1,000 hrs	80% @ 1,000 hrs	90% @ 3,000 hrs
Performan ce	Maximum Shear Stress4 (Channel Applications)	ASTM D 6460	7 lb/ft2	10 lb/ft2	12 lb/ft2	15 lb/ft2
	Maximum Slope Gradient (Slope Applications)	N/A	1:1 (H:V) or flatter	1:1 (H:V) or flatter	1:1 (H:V) or greater	1:1 (H:V) or greater

1 For TRMs containing degradable components, all values must be obtained on the non-degradable portion of the matting.
2 Minimum Average Roll Values, machine direction only.
3 Tensile strength of structural components retained after UV exposure.
4 Minimum shear stress that fully-vegetated TRM can sustain without physical damage or excess erosion (0.5 in soil loss)
during a 30 minute flow event in large scale testing. Acceptable large scale testing protocol includes ASTM D

6460 or independent testing conducted by the Texas Transportation Institute, Colorado State University, Utah State University, or other approved testing facility. Bench scale testing is not acceptable.

2.18 INLET PROTECTION

A. Drop-in Intake Protection:

1. Use a manufactured device that is inserted into the intake and is capable of trapping or filtering sediment from runoff prior to entering the storm sewer.

2. All components must be contained entirely below the surface of the intake grate.

3. Incorporate means of emergency outflow to prevent flooding if plugged with sediment.

B. Surface-applied Intake Protection:

1. Use devices or filter socks, placed around or over the intake, that are capable of trapping or filtering sediment from runoff prior to entering the storm sewer.

2. Do not allow the device to completely block or plug the intake, preventing inflow.

2.19 FLOW TRANSITION MATS

A. UV-stabilized HDPE plastic sheet with openings for vegetation growth and energy dissipation.

B. Use a nominal sheet size of 4 feet by 4 feet by 1/2 inch.

C. Use duckbill style anchors, as specified by the mat manufacturer.

2.20 ENGINEERING FABRIC

Comply with Iowa DOT Article 4196.01, B (Embankment Erosion Control) and Iowa DOT Materials I.M. 496.01, Appendix G.

PART 3 -EXECUTION
3.01 SWPPP PREPARATION

A. Prepare a SWPPP according to the requirements of the Iowa DNR NPDES General Permit No. 2.

B. Ensure that controls utilized in the SWPPP conform to the type and quantity of erosion and sediment controls specified in the contract documents. MidAmerican Energy Environmental Services will provide a Notice of Intent template that must be used

C. Submit the completed SWPPP to the Engineer and MidAmerican Energy Environmental Services for review and approval prior to filing the Notice of Intent.

D. Upon approval of the Engineer, file public notices, as required by the NPDES General Permit No. 2.

E. File the Notice of Intent and fee, as required by the NPDES General Permit No. 2 and any local ordinance requirements.

3.02 SWPPP MANAGEMENT

Coordinate and carry out all requirements of Iowa DNR NPDES General Permit No. 2 and any local ordinance requirements, including:

A. Update the SWPPP according to the requirements of the NPDES General Permit No. 2.

B. Revise the SWPPP and implement changes, as necessary, to prevent sediment or hazardous materials from being transported off the site.

C. Submit all SWPPP revisions to the Engineer for review and approval.

D. MidAmerican Energy will hire an approved Inspector to perform and maintain records of weekly erosion and sediment control site inspections, unless otherwise specified in the contract documents.

E. Maintain records of transfer of responsibility under the NPDES General Permit No. 2.

F. Retain all records on-site, or as required by the NPDES General Permit No. 2.

G. After final stabilization, MidAmerican Energy Environmental Services will file a Notice of Discontinuation, according to the NPDES General Permit No. 2 and at the recommendation of the Inspector and local authority.

H. Provide all records and documentation to the Engineer upon completion of the project. MidAmerican Energy will retain a copy of all records for the period required under the Permit.

I. Continue to perform the work required under this item throughout the duration of the project, and until final stabilization is achieved and a Notice of Discontinuation is filed.

3.03 EROSION AND SEDIMENT CONTROL INSPECTION

A. MidAmerican Energy will hire an approved Inspector to perform inspections according to and at frequency required by the Iowa DNR NPDES General Permit No. 2.

B. Schedule necessary maintenance or improvements for items that are included in the contract documents.

C. Notify the Engineer immediately of situations requiring attention beyond that provided for in the contract documents.

D. Provide copies of the inspection reports to the Engineer.

3.04 EQUIPMENT

Comply with Iowa DOT Article 2601.03.

3.05 COMPOST BLANKETS

A. Loosen the ground surface to a minimum depth of 1 inch.

B. Evenly spread compost, as specified in the contract documents, or as directed by the Engineer.

C. Divert concentrated flows away from the slope.

D. Do not operate heavy equipment over the compost blanket after placement, or throughout the required period of protection.

E. Inspect the ground under the blanket at regular intervals for signs of erosion.

3.06 FILTER BERMS

A. Install filter berm along the contour as specified in the contract documents, or as directed by the Engineer.

B. Turn the ends of the filter berm uphill to prevent runoff from flowing around the end of the berm.

C. When a vegetated berm is specified, apply seed to the surface of the berm.

D. Replace the berm when sediment accumulation reaches one-half of the height of the berm.

3.07 FILTER SOCKS

A. Installation:

1. Pneumatically fill mesh filter sock of size and length specified in the contract documents, or as directed by the Engineer. Alternative methods of filling the sock may be allowed upon approval of the Engineer.

2. Fill socks with filter material.

3. Place the filter sock along the contour as specified in the contract documents, or as directed by the Engineer.

4. Place additional filter material or soil from the site, on the upstream side of the sock, in the seam between the tube and the ground.

5. Construct a “J-hook” at each end of a continuous run of filter sock, by turning the end of the sock uphill, as necessary to prevent runoff from flowing around the ends when water behind the sock ponds up to a level even with the top of the sock.

6. Drive stakes into the ground at a maximum spacing of 10 feet, and as required to secure the sock and prevent movement.

7. Repair or replace non-functioning filter socks that allow water to flow under the sock, are torn, or are otherwise damaged, due to inadequate installation.

8. Remove filter material from damaged socks that are located along streambanks, around intakes, in ditches, or in other locations where the material may be carried to surface waters.

B. Removal: When specified in the contract documents, or as directed by the Engineer; remove the filter sock upon completion of the project, and after final stabilization is achieved; or as indicated in the SWPPP, if applicable.

1. Upon completion of the project, completely remove socks and filter material that are located along streambanks, around intakes, in ditches, or in other locations where the filter material may be carried to surface waters if the sock degrades and/or tears.

2. Slice the sock longitudinally. Remove and dispose of the filter sock material and stakes.

3. Spread the filter material and accumulated sediment to match finished grade and to ensure proper drainage.

4. If the site has been brought to finished grade and prepared for permanent seeding, spread and incorporate the filter material into the surface by tilling, or as required to break up any large particles and provide a finished surface suitable for permanent seeding.

C. Replacement:

1. When accumulated sediment reaches a level one-half the height of the sock, or when the sock becomes

clogged with sediment and no longer allows runoff to flow through, remove the sock as described above, and replace according to the installation instructions above.

2. At the Engineer's option, the existing filter sock and accumulated sediment may be left in place, and a new filter sock installed up-slope from the existing filter sock.

3.08 TEMPORARY ROLLED EROSION CONTROL PRODUCTS (RECP)

Install temporary RECPs according to the manufacturer's published installation recommendations, subject to the following minimum requirements:

A. Slope Application:

1. Grade and smooth surface. Remove all rocks, clods, vegetation, or other obstructions that will prevent direct contact between the RECP and the soil surface.

2. When specified, prepare seedbed and place seed and fertilizer according to Section 32 92 19, Seeding prior to placing RECP.

3. Install anchor trench at top of slope. Seed and fertilize trench after backfill and compaction, if seeding is specified.

4. Unroll the RECP down or horizontally across the slope.

5. Place consecutive blankets down the slope end-over-end, shingle style.

6. Overlap ends of consecutive rolls a minimum of 3 inches, and install anchors at a maximum spacing of 18 inches along all overlaps.

7. Overlap edges of adjacent rolls a minimum of 2 inches.

8. Install anchors at edge seams between rows.

B. Channel/Ditch Application:

1. When specified, prepare seedbed and place seed and fertilizer according to Section 32 92 19, Seeding, prior to placing RECP.

2. Place end of first roll in the anchor slot at the center of the upstream channel and secure with anchors.

3. Position adjacent rolls in the anchor slot, overlapping adjacent rolls a minimum of 3 inches.

4. Place backfill material in anchor slot and compact. Unroll RECP over compacted slot and secure with anchors.

5. Unroll RECP downstream. Maintain a minimum 3 inch overlap between adjacent rolls. Secure edge lap with anchors.

6. Install intermittent staple check slots every 30 feet.

7. Construct end lap at end of roll and beginning of new roll. Overlap roll ends with upstream RECP on top.

8. Excavate longitudinal trench along both sides of the channel at the outside edges of installation. Place outer edges of RECP into longitudinal slot. Install anchors, place backfill material, and compact.

9. Terminate installation at downstream end with staple check.

10. Install anchors in a regular pattern over entire area covered according to manufacturer's published recommendations (minimum three anchors per square yard).

3.09 WATTLES

A. Installation:

1. Construct a shallow trench, 2 to 4 inches deep, matching the width and contour of the wattle.

2. Install wattle along contour of slope.

3. Turn ends of wattle uphill to prevent water from flowing around ends.

4. Place and compact excavated soil against the wattle, on the uphill side.

5. Drive stakes through the center of the wattle, into the ground at a maximum spacing of 4 feet along the length of the wattle, and as needed to secure the wattle and prevent movement.

6. Abut ends of adjacent wattles tightly. Wrap joint with a 36 inch wide section of silt fence and secure with stakes.

B. Removal: When specified in the contract documents, or as directed by the Engineer, remove the wattle upon completion of the project, and after final stabilization is achieved; or as indicated in the SWPPP, if applicable.

1. Completely remove the wattle netting, filler material, and stakes.

2. Spread the accumulated sediment to match finished grade and to ensure proper drainage.

3. When allowed by the Engineer, the wattle netting may be sliced open and the filler material spread out over the ground. Removal of netting and stakes and spreading of sediment is still required.

C. Replacement:

1. When accumulated sediment reaches a level one-half the height of the wattle, or when the wattle becomes clogged with sediment and no longer allows runoff to flow through, remove the wattle as described above, and replace according to the installation instructions above.

2. At the Engineer's option, the existing wattle and accumulated sediment may be left in place, and a new wattle installed up-slope from the existing wattle.

3.10 CHECK DAMS

A. Synthetic Permeable Check Dam (HDPE):

1. Install according to the manufacturer's recommendations.

2. When specified, provide an RECP under the check dam, installed according to the manufacturer's recommendations.

B. Triangular Foam Check Dam: Install according to the manufacturer's recommendations.

C. Rock Check Dam: Construct according to plans.

D. Removal: When specified in the contract documents, or as directed by the Engineer, remove check

dams upon completion of the project, and after final stabilization is achieved; or as indicated in the SWPPP, if applicable.

1. Remove the check dam and dispose of materials, or salvage to the contractor.

2. Remove the accumulated sediment or spread to match finished grade; ensure proper drainage.

3. Stabilize the area disturbed by removal operations.

3.11 TEMPORARY EARTH DIVERSION STRUCTURES

A. Ensure positive drainage along the diversion toward the outlet area.

B. Adequately compact fill to prevent failures or seepage.

C. Outlet the diversion to undisturbed and/or stabilized areas only.

D. Stabilize the surface of the earth diversion with temporary erosion control seeding, as specified in Section 32 92 19, Seeding.

3.12 LEVEL SPREADERS

A. Butt multiple timbers together, as necessary to provide the required length.

B. Ensure the spreader is installed level in all directions. Adjust as necessary during construction to maintain spreader in a level condition.

C. Excavate a depression behind the spreader to the depth specified in the contract documents. The depression may be over-excavated up to 1 foot to provide an area for sediment accumulation.

D. Grade as required to prevent flow around the ends of spreader.

E. Remove the accumulated sediment from the depression when the depth is reduced below that specified in the contract documents.

3.13 RIP RAP

Install the quantity of rip rap (revetment stone or erosion stone) as specified in the contract documents.

3.14 TEMPORARY PIPE SLOPE DRAINS

A. Place slope drain on undisturbed soil or well compacted fill.

B. Carefully compact cohesive soils around inlet ends of the drain in 6 inch lifts.

C. Discharge slope drain to a stable outlet or to a sediment retention device.

3.15 SEDIMENT BASIN OUTLET STRUCTURES

A. Concrete Base: Construct the concrete base and anchor riser section, as shown on plans.

B. Dewatering Device:

1. Drill holes in the riser section. The number, diameter, and configuration will be specified in the contract documents.

2. Wrap the perforated section of the riser pipe with metal hardware cloth.

C. Anti-vortex Device: If required by the contract documents, firmly attach the cylinder to the top of the riser by welding or other means. Comply with plan details for fabrication.

3.16 ANTI-SEEP COLLAR

A. General: Place backfill material and compact over excavation areas to a minimum of 95% Standard Proctor Density per Section 31 23 33 Trenching and Backfilling.

B. Concrete Collar:

1. Place collars a minimum of 2 feet from pipe joints.

2. Provide Class C concrete per Section 33 49 00 Storm Drainage Structures.

C. CMP Collar:

1. Provide collar of same gage as the pipe barrel on which it is used.

2. Paint or tag unassembled collars to identify matching pairs.

3. Furnish each collar with two 1/2 inch diameter rods with tank lugs for connecting collars to pipe.

4. Install collar with corrugations vertical.

5. Seal the tap between the two half sections and between the pipe and connecting band with a bituminous jointing compound at the time of installation.

3.17 SEDIMENT TRAPS

Construct the storage area to the size and elevations specified in the contract documents.

3.18 SILT FENCES

A. Installation:

1. Install material along the contour of the ground, as specified in the contract documents, or as directed by the Engineer.

2. Install silt fence with a mechanical soil slicing machine that creates a slit in the ground while simultaneously installing the fabric. The trenching method may be used when situations will not allow soil slicing, as determined by the Engineer.

3. Construct a “J-hook” at each end of a continuous run of silt fence, by turning the end of the silt fence uphill, as necessary to prevent runoff from flowing around ends when water behind the fence ponds to a level even with the top of the fence.

4. Insert 12 inches of fabric to a minimum depth of 6 inches (fabric may be folded below the ground line).

5. Compact installation by driving along each side of the silt fence, or by other means, as necessary to adequately secure the fabric in the ground, to prevent pullout and water flow under the fence.

6. Drive steel posts into the ground alongside the silt fence, to a minimum depth of 20 inches, unless otherwise specified by the Engineer. Space posts at 5 feet on-center maximum, or as required to adequately support silt fence.

B. Maintenance: Repair or replace non-functioning silt fence that allows water to flow under the fence, is torn, or is otherwise damaged, due to inadequate installation, at no additional cost to the Contracting

Authority.

C. Removal:

1. Remove the silt fence upon final stabilization of the project area, or according to the staging indicated in the SWPPP.

2. Remove and dispose of silt fence and posts.

3. Remove sediment or spread to match finished grade; ensure proper drainage.

4. Stabilize the area disturbed by removal operations.

D. Replacement:

1. When accumulated sediment reaches a level one-half the height of the fence, remove the silt fence as described above, and replace according to the installation instructions above.

2. At the Engineer's option, the existing silt fence and accumulated sediment may be left in place, and a new silt fence installed up-slope from the existing silt fence.

3. When allowed by the Engineer, the existing silt fence may be left in place and the accumulated sediment removed to the original ground line and within 6 inches of the silt fence. Carefully inspect the existing silt fence for structural integrity and signs of undermining. Make any necessary repairs.

3.19 STABILIZED CONSTRUCTION ENTRANCE

A. Install a stabilized construction entrance at all locations where construction traffic leaving the site presents the potential for sediment track-out.

B. Remove vegetation and excavate soft soils from entrance area. Thoroughly compact subgrade prior to placing stone.

C. Install culvert under entrance if necessary to maintain drainage.

D. Grade entrance to prevent runoff from flowing onto street. Direct all runoff from entrance to a sediment retention device.

E. When specified, install subgrade stabilization fabric prior to placing crushed stone.

F. Install layer of crushed stone to the thickness (6 inches minimum) and dimensions specified in the contract documents.

G. Remove the accumulated sediment and install new stone, as required to prevent track-out.

3.20 DUST CONTROL

A. Water: Apply frequent light watering to ground surface, as required to control dust.

B. Calcium Chloride: Apply according to Iowa DOT Section 2314.

C. (Not Used)

D. Soapstock (Soybean Oil):

1. Loosen the top 1 to 2 inches of the roadway surface.

2. Apply undiluted soapstock at a rate of 0.70 gal/yd^2.

3. Allow product to penetrate through the loosened material.

4. Tight-blade road surface.

3.21 EROSION CONTROL MULCHING

A. Conventional Mulching:

1. Use conventional mulching when the surface cannot be stabilized by seeding, due to season or ground conditions.

2. Uniformly distribute mulch over the required areas, at a rate of 2 tons/acre for dry cereal straw, or 2.5 tons/acre for prairie hay.

3. Work the mulch into the soil with a mulch tucker, designed to anchor the mulch into the soil, by means of dull blades or disks.

B. Hydromulching:

1. Place mulch and tackifier (if applicable) in equipment specifically manufactured for hydraulic mulching.

2. Mix materials with fresh, potable water using a combination of re-circulation through the equipment's pump and mechanical agitation to form a homogeneous slurry.

3. If necessary, dampen any dry, dusty soil as required to prevent balling of the material during application.

4. Apply hydromulch in multiple layers from opposing directions, where possible.

5. Apply the slurry evenly over all specified areas, at the minimum component material rates specified:
   a. Wood Cellulose Mulch: 1) Mulch: 2,600 lb/acre dry weight. 2) Tackifier: 50 lb/acre.
   b. Bonded Fiber Matrix: 3,600 lb/acre dry weight.
   c. Mechanically Bonded Fiber Matrix: 3,600 lb/acre dry weight.

6. Retain and count empty bags of mulch to ensure final application rate.

3.22 TURF REINFORCEMENT MATS

Install according to the manufacturer's published installation literature for the product specified and application (slope or channel).

3.23 SURFACE ROUGHENING

A. Directional Tracking:

1. Do not use on slopes steeper than 3:1.

2. Operate tracked equipment up and down exposed slope to create ridges perpendicular to the slope.

3. Continue operation until the entire surface has been tracked.

B. Grooving/Furrowing:

1. May be used on all slopes.

2. Use rippers, disks, harrows, chisel plows, or other equipment capable of operating on the slope and creating grooves a maximum of 15 inches apart and 3 inches deep.

3. Operate equipment along the contour of the slope to create grooves that are perpendicular to the slope.

4. Perform over all exposed slopes as specified.

3.24 INLET PROTECTION

A. Install inlet protection devices according to the manufacturer's recommendations.

B. Remove the accumulated sediment, as required to maintain the inlet protection device in working order. Remove any accumulated sediment from streets open to traffic if it encroaches into the traveled roadway.

3.25 FLOW TRANSITION MATS

Install according to the manufacturer's published recommendations.

3.26 TEMPORARY EROSION CONTROL SEEDING

Comply with Section 32 92 19, Seeding.

END OF SECTION

SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base.

1.02 RELATED SECTIONS

A. Section 31 20 00 - Earthwork.

B. Section 32 13 13 - Concrete Paving.

1.03 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2001 (2004).

B. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2000a.

C. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2000.

D. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2002.

E. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994(R 2001).

F. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2000.

G. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

H. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.04 SUBMITTALS

A. Materials Sources: Submit name of imported materials source and provide material certifications.

1.05 PROJECT CONDITIONS

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate Base Course: Conforming to State of Iowa Highway Department standard 4121 unless otherwise stated in the plans.

2.02 SOURCE QUALITY CONTROL

A. Testing of samples for compliance will be provided before delivery to site.

B. If tests indicate materials do not meet specified requirements, change material and retest at Contractor's

expense.

C. Provide materials of each type from same source throughout the work.

D. Upon delivery of 1,000 tons of aggregate to the site prior to spreading of rock, owner's geotechnical engineer will test gradation of aggregate and verify it meets specification. Contractor must notify owner's geotechnical engineer with a minimum 4 working day notice.

E. During rock placement, gradation testing compliance will be required every 200 tons of aggregate material delivered to site. Contractor required to coordinate testing with geotechnical engineer. If aggregate does not pass gradation, contractor responsible for removal and replacement of material as determined by geotechnical engineer and owner.

F. Contractor responsible for any subsequent gradation testing that is required for aggregate that does not pass gradation tests.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

A. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

A. Under Paving:
   1. Place aggregate base course to a total compacted thickness as specified on site plan.
   2. Compact to 95 percent of maximum dry density.

B. Level and contour surfaces to elevations and gradients indicated.

C. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

D. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.

B. Variation From Design Elevation: Within 1/2 inch (12 mm).

3.05 FIELD QUALITY CONTROL

A. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556.

B. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").

C. If tests indicate work does not meet specified requirements, remove work, replace and retest at Contractor's expense.

D. Contractor shall coordinate work with testing laboratory before proceeding with each phase or stage of work.

3.06 CLEAN-UP

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including Bidding Requirements, General and Supplementary Conditions and Division I Specification Sections, apply to work specified in this Section.

B. Comply with ACI 316 "Recommended Practice for Construction of Concrete Pavements and Concrete Bases" for all work.

1.02 WORK INCLUDED:

Provide all labor, materials, equipment and supervision required to construct concrete pavement, driveways, parking lots, curbs, walks, steps, edging, etc. including:

A. Concrete.

B. Curing and sealing.

C. Contraction and expansion joints and fillers.

D. Vapor barrier.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 31 20 00.
B. Joint Sealant: Section 32 13 73.

1.04 QUALITY ASSURANCE:

A. Cost of field and laboratory testing will be borne by the Owner. Testing by laboratory approved by the Owner. Lab reports shall be simultaneously forwarded to the Owner, Contractor and Engineer.

B. Testing:
   1. Slump to be checked in accordance with ASTM C143. One test minimum per hour.

   2. Air content measured in accordance with ASTM C231, or C173. One test minimum daily.

   3. Strength tests:
      a. Take one set of three (3) cylinders for each one hundred fifty (150) cubic yards or part thereof. Minimum one set of three (3) cylinders per each day's pour.
      b. Each cylinder shall be plainly marked showing cylinder designation (1A, 1B, 1C).
      c. Job cure each cylinder three (3) days.
      d. After three (3) days, send cylinders A and B to the laboratory approved by the Engineer for testing at ages seven (7) days and twenty-eight (28) days. Cylinder C to remain at the job as a "spare" cured under same conditions as concrete in the area from which it was taken.
      e. The date and location of each sample shall be marked on the Contractor’s job set of plans.

f. Load and core tests shall be required only if cylinder tests indicate concrete does not meet Specifications. Such tests, if deemed advisable by the Engineer, shall be arranged and paid for by the Contractor.

4. Pavement Smoothness: Evaluate pavement smoothness for all PCC pavement surfaces. Straightedge: The Engineer will check PCC pavement surfaces with a 10 foot straightedge placed parallel to the centerline. Areas showing high spots of more than 1/4 of an inch in 10 feet will be marked. Complete surface corrections according to the procedures in Iowa DOT Section 2316 to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straightedge. Surface corrections will be completed at the direction of the Engineer with no additional cost to the Owner.

5. Pavement Thickness:

a. At locations determined by the Engineer, cut samples from the pavement by drilling with a core bit that will provide samples with a 4 inch outside diameter. Restore the surface by tamping low slump concrete into the hole, finishing, and texturing. The Engineer will witness the core drilling, identify, and take possession of the cores. The Engineer will determine the core locations, measure the cores, and determine the thickness index according to Iowa DOT Materials I.M. 346 and 347, except as modified as follows:

i. For regular or irregular shaped areas, use a lot size of 1,000 square yards. Include remnants less than 500 square yards in the last lot and remnants greater than 500 square yards in a separate lot. Take a minimum of three cores per project.

ii. For any core with a deficiency greater than 0.15 inch, take two additional cores in that pavement lot and use the average of the three cores.

b. Coring of pavement or other work for thickness determination may be waived by mutual agreement for sections of the same design thickness less than 2,500 square yards.

c. Based on the thickness index determined by the Engineer, the pavement payment will be as shown below:

Pay Factor for PCC Pavement Thickness

Thickness Index Range (in.)	Percent Payment
0 to -0.15	100
-0.16 to -0.25	95
-0.26 to -0.50	85
Greater than -0.51	As determined by the Engineer

d. If the thickness index deficiency is greater than 0.51, the Engineer will study the extent and severity of the deficiency of the pavement areas. The Engineer will require one of the following:

i. Removal and replacement of the deficient areas with pavement complying with the contract documents at no additional cost to the Owner.

ii. Completion of an agreement that provides a combination of an extended guarantee period and payment penalty and allows the deficient pavement to be left in place.

1.05 SUBMITTALS:

A. Certification of concrete C-4 design mix with Class 3 durability aggregate by a testing laboratory. Submit prior to placement.

B. Submit plan for construction sequence and schedule prior to commencing construction.

C. Submit jointing plan 10 days prior to paving.

1.06 CODES, PERMITS AND FEES:

A. The entire installation shall fully comply with all local and state laws and ordinances, and with all established codes applicable thereto.

1.07 SITE DISTURBANCES:

A. Take precautions to ensure that equipment and vehicles do not disturb or damage existing site grading, walks, drives, utilities, plants, etc.

B. Verify locations and depths of all underground utilities prior to excavation.

C. Repair and/or return to original condition any damage caused by Contractor's negligence at no cost to Owner.

D. Provide temporary barricades and warning lights as required for protection of project work and public safety.

1.08 PAVEMENT PROTECTION

A. Weather Conditions: Do not place concrete when stormy or inclement weather or temperature prevents good workmanship. Temperature restrictions and protection requirements may be modified by the Engineer under unusual conditions. Pavement damaged by inclement weather shall be removed and replaced.

1. Cold Weather:

a. Paving: Do not place aggregates containing frozen lumps, and do not place concrete on a frozen subgrade or subbase. Take all necessary actions to prevent the pavement from freezing.

1) Concrete mixing and placement may be started, if weather conditions are favorable, when the air temperature is at least 34ºF and rising. At the time of placement, concrete must have a temperature of at least 40ºF.

2) Stop mixing and placing when the air temperature is 38ºF or less and falling or if the temperature stops rising and does not reach 38ºF.

b. Protection: Prior to applying protection, cure all concrete pavement and curb/gutters, including exposed edges of the pavement and curb. In addition, protect concrete less than 36 hours old as follows

Night Temperature Forecast	Type of Protection[1]
35°F to 32°F	One layer of burlap for concrete.
31°F to 25°F	Two layers of burlap or one layer of plastic on one layer of burlap.
Below 25°F	Four layers of burlap between layers of 4 mil (100 µm) plastic or equivalent commercial insulating material approved by the Engineer.

[1] The protection shall remain until one of the following conditions is met:
a. The pavement is 5 calendar days old.
b. Opening strength is attained.
c. Forecasted low temperatures exceed 35°F for the next 48 hours.
d. Forecasted high temperatures exceed 55°F for the next 24 hours and subgrade temperatures are above 40°F.

1) Shut down paving operations in time to comply with protection requirements outlined above. During cold weather, allow more time for finishing and protection. Perform all finishing and covering operations prior to darkness. Temperature restrictions and protection requirements may be modified by the Engineer.
2) Equivalent commercial insulating material approved by the Engineer may be used. This material must be waterproof and have a minimum R value of 1.0. If initial set has not yet occurred, place a layer of burlap on top of concrete prior to placing insulating blankets.
3) Use a method of protection and materials that will maintain the concrete temperature above 40°F.

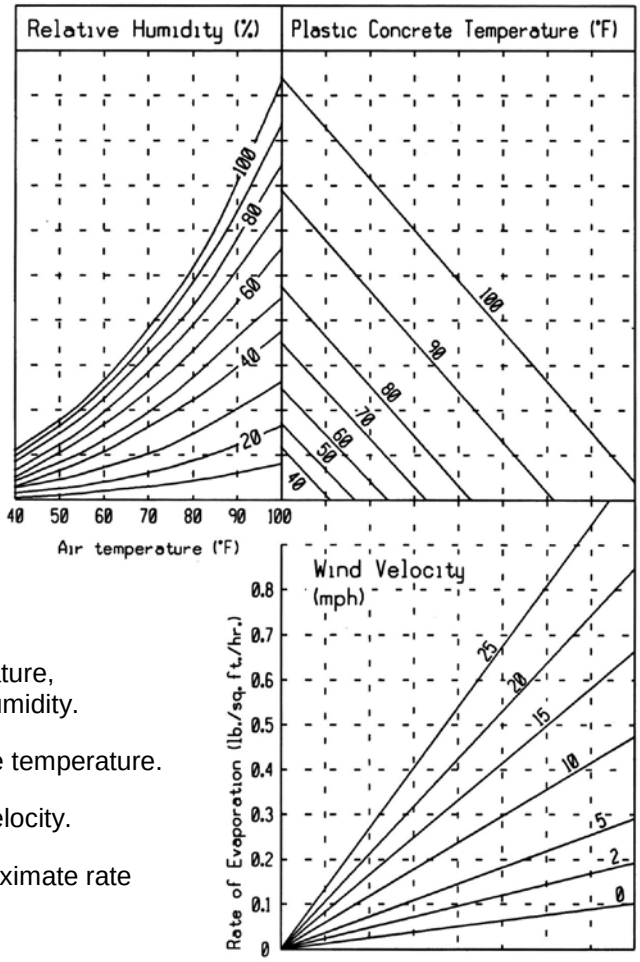
2. Hot Weather: Hot weather condition is defined as any combination of the following conditions that tend to impair the quality of plastic concrete by accelerating the rate of moisture loss and rate of cement hydration causing thermal shrinkage and resulting in plastic shrinkage cracking:

- High Ambient Temperature
- High Concrete Temperature
- Low Relative Humidity
- High Wind Velocity
- Solar Radiation

a. General:
1) During hot weather conditions, the Engineer may restrict concrete placement to early morning or evening hours.
2) During hot weather conditions, advise the Engineer of the results of the theoretical evaporation rate throughout paving operations.

b. Determine the Theoretical Rate of Evaporation: Use the following chart and the National Weather Service's predicted maximum air temperature, relative humidity, and maximum steady wind velocity without gusts, for the date and the location of the paving pour.

Theoretical Rate of Evaporation Chart



To Use this Chart:

1. Enter with air temperature, move up to relative humidity.
2. Move right to concrete temperature.
3. Move down to wind velocity.
4. Move left , read approximate rate of evaporation

c. If the evaporation rate exceeds 0.1 pounds per square foot per hour but is less than 0.3 pounds per square foot per hour, provide the following concrete evaporation protection.
   1) Immediately apply an approved evaporation retarder to the concrete pavement and curbs or increase the surface cure application to 1.5 times the standard specified rate.
   2) Take special precautions to ensure that the forms and subgrade are sufficiently moist or protected to avoid lowering the water content at the pavement/subgrade interface. In hot weather conditions, moisten the subgrade the evening before operations.
   3) Ensure that the time between placing and curing is minimized and eliminate delays.
   4) Moisten concrete aggregates that are dry and absorptive.
   5) Use a fog spray to raise the relative humidity of the ambient air if there is a delay in immediately applying the curing compound.
   6) Minimize solar heat by shading, wetting, or covering concrete chutes or other equipment that comes in contact with plastic concrete.

d. If the evaporation rate is 0.3 pounds per square foot per hour or greater or if winds are greater than 25mph, discontinue placement of concrete.

3. Rain Protection:

a. The Contractor shall have available, near the site of the work, materials for proper protection of the edges and surface of concrete. Protective material may consist of sheets of burlap, or plastic film. Planks or other material with suitable stakes that can be used as temporary forms shall also be on hand.

b. If initial set has not occurred, contractor shall take every precaution necessary to protect the surface texture of the concrete.

c. Failure to properly protect concrete shall constitute cause for removal and replacement of defective pavement, if so determined by the Engineer.

C. Protection from Traffic:

1. General:

a. Protect the new pavement and its appurtenances from traffic, both public and that caused by the Contractor's own employees and agents, at no additional cost to the Owner. This includes the erection and maintenance of warning signs, lights, barricades, watchmen to direct traffic, and pavement bridges or crossovers.

b. Do not operate equipment with metal tracks, metal bucket blades, or metal motor patrol blades directly on new paving. Do not unload soil or granular materials, including base rock for storage and future reloading directly onto new paving.

2. End of Day's Run:

a. At the end of each day's run and at all side streets, erect and maintain safety barriers and fencing as necessary to protect the pavement from damage.

b. Install safety fences within 1 hour of the completion of finishing and curing operations. Leave fences in place and maintained until the concrete has attained the minimum strength or age.

c. Intermediate safety fences may be required for the purpose of opening the pavement for access to a side road, side street, or entrance.

3. Repair of Damages: At the discretion of the Engineer, and at no additional cost to the Owner, repair or replace any part of the pavement damaged by traffic or other causes occurring prior to final acceptance of the pavement.

1.09 USE OF PAVEMENT

Time for opening pavement for use is determined by age and test results from cylinder or beams taken during placement.

Minimum Age and Tested Strength of Pavement Before Opening

Class of Mix	Type of Cement	Minimum Age For Opening (1)	Minimum Compressive Strength (psi)	Minimum Flexural Strength Center Point (psi)
C	Type I	7 Days (2)	3,000	500
M	Type I	48 Hours	3,000	500

(1) Opening without testing only allowed upon approval of Engineer

(2) Five calendar days for concrete 9 inches thick or more.

PART 2 PRODUCTS

2.01 CONCRETE STRENGTH:

A. Concrete mix for exterior slabs and steps:
   1. Minimum of 4000 psi compressive strength at twenty-eight (28) days.
   2. Minimum air content of 6.0%. To allow for loss during placement, the air content of fresh, un-vibrated concrete shall be 7.0%.
   3. Maximum of 15% replacement of cement with fly ash will be permitted.
   4. Slump four inches (4") maximum.

2.02 MIXING:

A. Except as otherwise specified, concrete shall be ready-mixed or job-mixed at the Contractor's option, and in accordance with requirements of ACI 318-77. Ready-mixed concrete shall be mixed and delivered to the project in accordance with ASTM C94. Maximum mixing time is one (1) hour.

2.03 PORTLAND CEMENT:

A. ASTM C150, type I.

2.04 SAND:

A. Clean, hard, washed and well graded. Sand shall conform with ASTM C33.

2.05 COARSE AGGREGATE:

A. Aggregate shall conform to ASTM C33. Aggregate for footings and other unexposed concrete may be gravel. Aggregate for exterior concrete and surfaces shall be limestone (max. size 1"). No substitutions will be allowed. Evidence of staining due to impurities will be cause for rejection of work.

2.06 MIXING WATER:

A. Clean and free from oil, acid and injurious amounts of vegetable matter, alkalies and other impurities.

2.07 ADMIXTURES:

A. Air entrainment: 6%, + 1% or -0.5%.

B. Air-entraining agents shall conform to ASTM C260.

C. Calcium Chloride is not to be used. No other admixtures shall be used without the expressed, written consent of the Engineer.

D. A water-reducing agent may be used as deemed necessary, to be in conformance with the latest ASTM requirements.

2.08 EXPANSION JOINT FILLERS:

A. See Specification Section 32 13 73.

2.09 EXPANSION JOINT SEALANT:

A. See Specification Section 32 13 73.

2.10 CURE AND SEAL:

A. Comply with Iowa DOT Section 4105.
   a. All colored concrete pavement shall be cured using Iowa DOT 4105.07, Clear Compounds conforming with AASHTO 148, Type 1-D, Class A.
   b. All standard color concrete pavement shall be cured using Iowa DOT 4105.05, White Pigmented Compounds applied at a rate of 0.067 gallons per square yard.

2.11 REINFORCING STEEL MATERIAL:

A. All reinforcing steel shall be epoxy coated and conform with Iowa DOT section 4151.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION:

A. Excavate, fill, compact, grade and prepare subgrade as specified in Earthwork Section 31 20 00.

B 1. Unless otherwise ordered by the Engineer, the subgrade, at time of placing concrete for Concrete Pavement, shall be in a uniformly moist but not muddy condition to a depth of not less than one inch.

2. Subgrade Loading:
   a. Where concrete trucks must travel on a prepared soil-type subgrade to unload and, as approved by the Engineer, watering of the subgrade must be limited to just ahead of the paving machine.
   b. Repetitive loading on the subgrade by concrete trucks shall be minimized by entering and exiting the subgrade on side streets.
   c. Loads in excess of the legal axle load shall not be allowed on the completed subgrade.
   d. Partially loaded trucks may be required.
   e. If subgrade/subbase failure occurs, the repair shall be coordinated with the Engineer.

3. Paving Suspended:
   a. The paving operation shall be suspended where subgrade stability has been lost.
   b. No concrete shall be placed upon a subgrade which has become unstable, bears ruts or tire marks of Contractor's equipment or which is excessively softened by rain until such subgrade has been reconsolidated and replaned or reshaped to correct the objectionable condition.
   c. If necessary, scarify to a minimum depth of 6 inches, aerating, and recompacting at the Contractor's expense. Recompaction shall meet requirements of Section 31 20 00.

4. Maintenance of Subgrade:
   a. The Contractor is responsible for maintenance of the completed subgrade during subsequent construction activities.
   b. Before allowing hauling equipment to use the completed subgrade, the Contractor must be satisfied as to the effect this hauling equipment may have on the partially completed work.

3.02 SURFACE FIXTURE ADJUSTMENT

A. Adjust manhole frames and other fixtures within area to be paved to conform to finished surface.

B. Clean outside of fixture to depth of pavement before concrete placement.

C. Box out fixtures for later adjustment where allowed. Size and shape of box out for intakes as shown in Standard Drawings.

3.03 FORMS:

A. Set base of forms at or below subgrade elevation with top of forms at pavement surface elevation.

C. Extra height forms with Engineer approval may be used to back up integral curb and paving slab; set base at or below subgrade elevation with top of form at top of curb elevation.

D. Secure forms in place to required grade and alignment.

E. If voids occur under forms, remove forms and rework subgrade to proper elevation and density; reinstall forms.

F. If the soil supporting the form is softened by rain or standing water so that form is inadequately supported, remove forms and rework subgrade to proper elevation and density; reinstall forms.

G. Coat forms with release agent before concrete is placed.

H. Place forms true to alignment and free of latent concrete. Use wood or steel forms adequately staked and braced for all exposed slab edges.

I. Leave forms in place not less than eight (8) hours after concrete is placed. If removal causes damage to concrete, leave forms on as long as necessary to prevent damage. Remove forms with care to prevent cracking, spalling or overstressing concrete.

3.04 REINFORCING PLACEMENT

A. Reinforcing metal shall be clean, straight, free from distortion and rust, and shall be firmly secured in position as detailed.

B. All reinforcing metal shall be placed in approved storage to prevent damage; do not distribute along the work site except as needed to avoid delay in paving.

C. Place reinforcing steel as shown on the detailed drawings or as specified; support and secure bars by approved chair and wire assemblies; bars to be checked by the Engineer upon notification from the Contractor.

D. Place steel centered in the pavement reasonably in advance of the paving operations.

E. Joint Steel:

1. LONGITUDINAL: All joints shall be constructed of the type, dimensions, and at the locations required by the plans or special provisions. All longitudinal joints in drive lanes shall be L-1 or L-2 joints and have steel, unless specifically specified otherwise on plans. Interior, parking lot joints do not need steel and shall be of type C.

2. TRANSVERSE: All transverse joints shall be either type C or type DW with steel for a day's work joint.

2. Tie bars for all longitudinal joints shall be installed so as to be in the intended position in the completed pavement. Tie bars for all longitudinal joints shall be positioned on chairs and secured against movement with metal stakes during placing and finishing of concrete unless otherwise approved by the Engineer. If approved by the Engineer, bars may be placed in position by a machine or other method. For tie steel that is placed mechanically in plastic concrete, the Engineer may:
   a. Manually check locations and depth of the steel in the plastic concrete behind the slip form paver using the following frequencies:
      - once every 200 lineal feet for tangent roadway sections
      - in at least three locations within all horizontal curve sections
      - for each inspection, at least two tie steel locations within a panel
   b. Using a magnetic locator, verify locations of tie steel in hardened concrete every day. Check out-of-tolerance tie steel to identify the extent of the problem for a retrofit correction.

3. The Contractor shall provide adequate means to ensure that the load transfer devices and tie bars are properly secured to maintain correct position and alignment during the placement of concrete.

4. Other tie bars shall be placed in such a manner as to ensure that the bars are located in reasonably close conformity with the specifications.

5. Care should be taken to prevent disturbance or damage of the joint assembly. Bars must be supported by approved chairs or method approved by Engineer.

3.05 JOINTS:

A. The Contractor shall submit a concrete jointing plan to the Owners Representative for approval 10 days prior to the start of paving. Joint design for concrete pavement shall be based on the current Guide for Design and Construction of Concrete Parking Lots published by the American Concrete Institute (ACI 330R-92). It is desired to have joint lines match edges of travel lanes. Joint locations shall be chalked with a string line before sawing.

B. Saw cut control joints. Joints to be 1/8" minimum and 1/4" maximum width. All transverse contraction joints shall be sawed at a maximum spacing of 30T, where T is the thickness of the pavement in feet. In sidewalks, space joints to create square panels unless a maximum spacing of 21T is exceeded, then use rectangular panels, unless shown on the plans. All walks 13' or more in wide shall get a longitudinal centerline L-1 Joint with Steel and square panels.

All joints shall be sawed to a depth shown below.

	Minimum Sawcut Depth	
	Conventional Saw	Early "Green" Saw
Transverse "C" Joint	T/4±1/4"	1 1/4"
Longitudinal Joint	T/3±1/4"	Not Allowed

C. Timing:

1. Begin transverse joint sawing as soon as the concrete has hardened sufficiently to allow sawing without raveling or moving of aggregate. Saw joints before uncontrolled cracking takes place.

2. Saw all joints in a single cutting operation for a specific joint. Make saw cuts true to line and to the dimensions specified in the contract documents.

3. Discontinue sawing a joint if a crack develops ahead of the saw.

4.Saw longitudinal joints within 24 hours of the concrete being placed.

5. If necessary, continue the sawing operations both day and night.

6. The concrete must be capable of supporting the sawing operations to allow the use of an early green concrete saw.

7. Replace pavement with uncontrolled or random cracking at no additional cost to the Owner. Replace complete panel sections by means used for Full Depth PCC Repair Patches. Thickness of repair shall be original design thickness plus 2 inches. Place RD joints as shown in SUDAS Detail 7040.10 for patch.

8. Use wet sawing for dust control when specified in the contract documents.

D. Round outside edges of sidewalk with edging tool with approximately one quarter-inch (1/4") radius.

E. Round edges of sidewalk or curbs adjacent to expansion joints with edging tool with approximately one-eighth inch (1/8") radius.

F. Construction Joint - and tied joints shall be used at ends of all concrete pours. Bars to extend through joints a minimum of twenty-four (24) bar diameters.

G. Expansion joints (isolation joints) shall be installed in concrete pavement slabs and sidewalks where the concrete meets other structures such as light pole bases, intakes, buildings and all other similar structures. Hold joint material down one-half inch (1/2") and fill with sealant. Also used where sidewalk meets concrete curb.

H. Joints sawed with an early "green" concrete saw shall be washed out prior to sealing. The concrete must be capable of supporting the sawing operations to allow the use of an early green concrete saw.

I. Construction Joints:

1. Longitudinal or transverse construction joints shall be placed between adjacent lanes of concrete and at end-of-day header runs.

2. Manhole boxouts shall be located and placed on grade prior to paving. Manhole boxouts are required for two piece castings for sanitary/storm manholes.

3. The longitudinal construction joints shall be an approved joint type with legs unless machine placed.

4. Transverse construction joints shall employ load transfer devices (Header) and shall be placed whenever concrete placement is delayed for more than 30 minutes.

3.06 CONCRETE PAVEMENT PLACEMENT

A. Set survey control stakes at 25 foot maximum spacing including high and low points. Additional staking

may be required by the Engineer.

B. The concrete shall be placed, consolidated, and finished to the widths and depths outlined in the plans.

B. All Type 2 and Type 3 paving sections longer that 100' in length shall be poured with the slab in a single slip-form paving machine operation. This includes, but not limited to all 10' wide or greater trails longer than 250 feet in length.

D. The concrete shall be deposited upon the supported reinforcement keeping segregation to a minimum.

E. Concrete shall be deposited to the full depth of the pavement in a single operation.

F. Necessary hand spading and spreading shall be done with shovels and not rakes.

G. Use laser screed for all Type 1 uniform width slabs 8.5 feet or more in width and 250 feet or more in length.

H. When pavement is constructed in separate lanes, the junction line in straight sections shall not deviate from the true line shown on the plans by more than ½ inch at any point and shall be tooled to the radius shown on the plans.

I. Place concrete to full depth in single operation. Keep a uniform pile of concrete in front of the paving machine, up to a maximum of 6 to 8 inches above the design surface elevation.

J. The concrete shall be distributed and spread as soon as placed. A mechanical concrete spreader may be used.

K. Concrete Screed:

1. The concrete shall then be struck off and screeded by mechanical means.

2. The striking off or screeding shall conform to the crown and cross section shown on the plans.

3. If, in the operation of subgrade or finishing equipment, it is necessary to operate one or both sets of wheels or tracks on previously placed concrete, the wheels or tracks shall be adjusted so that the bearing on the concrete will be not less than 3 inches from the edge of the pavement.

4. When operating with two wheels on the previously placed concrete and two wheels on the form, the form wheels shall be double flanged.

5. All wheels operating on the pavement shall be flangeless and rubber tired. All tracks operating on the pavement shall use rubber, wood, or belting pads.

L. The top of the forms shall be kept clean from accumulations of concrete, and the travel of the finishing machine on the forms shall be maintained true without lift, wobbling, or other variations tending to affect precision of finish.

M. When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval the Engineer. Vibrating equipment shall meet the requirements of IDOT Section 2301.07. Vibrating equipment shall, under no circumstances, be used as a

tool for moving concrete laterally on the grade.

3.07 FINISHING:

A. Screed, level and float all slabs to true, level and straight lines.

B. Exterior slabs and platforms to be medium hair broom finish, with no coarse aggregate visible, unless otherwise specified on drawings.

C. Tolerances on all surfaces not more than three-sixteenths inch (3/16") in ten foot zero inch (10'- 0").

D. Formed surface finish:
   1. Remove bulges, fins, form marks and roughness from exposed surfaces by grinding.
   2. Subject to Engineer's approval, fill honeycombed and other defective areas by cutting out to solid concrete (minimum depth= 1") with straight edges and at right angles to the surface. Dampen area to be patched, brush on grout of equal parts Portland Cement and sand and follow immediately with patching mortar. Large or objectionable areas will require full removal and replacement at Engineer's discretion.
   3. Patching mortar to be not richer than one (1) part Portland Cement to three (3) parts sand. Color of patching mortar shall match the adjacent concrete. (Substitute white Portland Cement for part of the grey cement as needed to provide color match.)
   4. Trowel or burlap rub patched areas to match the surrounding concrete area. Clean all walls upon completion.
   5. Exposed concrete wall faces and tops to have a uniform smooth rubbed finish. Moisten concrete surfaces and rub with Carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.

3.08 SURFACE CURING

A. Apply liquid curing compound in a fine spray to form a continuous, uniform film on the horizontal surface and vertical edges of pavement, curbs and back of curbs immediately after surface moisture has disappeared, but no later than 30 minutes after finishing. With approval of the Engineer, the timing of cure application may be adjusted due to varying weather conditions and concrete mix properties to ensure acceptable macrotexture is achieved.

   1. Use a white pigment liquid curing compound.

B. Apply compound with power sprayer; rate of application not less than 0.067 gallon per square yard (15 square yards per gallon); do not dilute compound.

C. If forms are used, apply to pavement edges and back of curbs within 30 minutes after forms are removed.

D. Ensure liquid curing materials are well agitated in the supply drum or tank immediately before transfer to the sprayer. Keep curing materials well agitated during application.

E. Hand operated sprayers may be used for small and irregular areas.

G. If forms are used, apply to pavement edges and back of curbs within 30 minutes after forms are removed.

H. If, due to other operations, the coating is damaged within 72 hours after being applied, immediately re-coat the affected areas. Coating of the sawed surface with curing compound will not be allowed on joints that

are to be sealed. When pavement is opened to traffic prior to 72 hours after application of the curing coating, a re-coating will not be required.

3.09 JOINT SEALING

A. Timing:

1. Unless otherwise provided, before any portion of the pavement is opened to the Contractor's forces or to general traffic, joints that require sealing shall be sealed.

2. The Engineer may limit the wheel loads and axle loads of equipment operating on the pavement during this operation, if prior to the age and strength specified in Section 1.08 above. Additional tests to determine the modulus of rupture may be required.

B. Cleaning:

1. For those joints that are not to be sealed, cleaning is not required.

2. Within 3 hours after a joint has been wet sawed to the finished dimension, flush the wet sawing residue away from the sawed faces using a high pressure water blast operating with a minimum pressure of 1,000 pounds per square inch. Within 3 hours after a joint has been dry sawed to the finished dimension, blow the dry sawing residue from the joint using air compressors that provide moisture and oil free compressed air.

3. Immediately prior to installation of sealant, clean joints with an air blast. Do not perform sealing until visual examination verifies the joint surfaces appear dry, in addition to being clear of dust and contamination.

C. Sealing:

1. Prepare and install joint sealer in the joint and to the proper level specified in the contract documents and as recommended by the manufacturer.

2. Heat hot-poured sealers in a thermostatically controlled heating kettle; heat the material to the temperature required for use, but not above that recommended by the manufacturer. After sealing, remove excess sealer from the pavement surface.

3. Seal joints the same day they are cleaned. Apply sealant only when the joint surfaces appear dry by visual examination.

4. Place joint sealer only when the pavement and ambient air temperatures are 40°F or above. When near this minimum, additional air blasting or drying time, or both, may be necessary to ensure a satisfactory bond to the joint faces. When this sealer cannot be properly placed due to late fall work, submit a joint construction plan and sealing details to the Engineer for approval before commencing paving. Delay the cleaning, sealing, and, if required, resawing of joints until the following spring. This delay requires the Engineer’s approval.

5. When surface correction is required, repair seals damaged from the corrective work. Joint preparation, cleaning, and sealing may be delayed until after corrective work, provided the pavement is not opened to traffic before corrective work is performed.
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3.10 SEPARATE CURB AND GUTTER CONSTRUCTION (FOR USE WITH HMA PAVING AREAS)

A. Construct curb and gutter as shown on drawings.

B. Use paving machine slip-form for curb; curb mule or similar mechanical equipment providing equivalent results.

C. Hand methods shall be allowed for radius, returns, and sections of curb and gutter 75 feet or less in length.

D. When depressed curb at driveways and where sidewalk intersects street, use templates to form backs of such curbs.

E. Form and construct curb by hand only where barrier or depressed curb is required and where small radii or other special sections preclude use of mechanical equipment.

F. Finish curb as rapidly as finishing operations on pavement permit. Maximum distance behind paving machine is 100 feet.

G. Remove free water, latency, dust, leaves, or other foreign matter prior to placing concrete for curb.

H. Use freshly mixed concrete; do not store concrete in receptacles at side of pavement for use in curb at a later time; do not use concrete requiring retempering.

I. Vibrate or puddle concrete to secure bond with paving slab and eliminate rock pockets.

J. Secure final finish on curbs by hand method, including 6 foot straightedge or 6 foot slipform.

K. Edge, protect, and cure curb in same manner as pavement.

L. Check surfaces of curb and gutter with 10 foot straightedge; correct variations greater than 1/8 inch; remove and replace curbs having varying cross section.

3.11 DEFECTS OR DEFICIENCIES

Pavement containing cracks, fractures, spalls, or other defects, as determined to be unacceptable by Owner/Engineer, shall be removed and replaced at no cost to Owner. Remedy to be determined by Engineer. In lieu of the above, the Owner/Engineer may approve an extended warranty or price adjustment.

Replace pavement with uncontrolled or random cracking at no additional cost to the Owner. Replace complete panel sections by means used for Full Depth PCC Repair Patches. Thickness of repair shall be original design thickness plus 2 inches. All matches must conform to Iowa SUDAS 2013 Detail 7040.101 for patches.

END OF SECTION

SECTION 32 13 73

PAVEMENT JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Expansion and contraction joints within cement concrete pavement.
   2. Joints between cement concrete and asphalt pavement.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each type and color of joint sealant required.

C. Product test reports.

D. Compatibility and Adhesion Test Reports: From sealant manufacturer.

1.03 QUALITY ASSURANCE

A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.04 WARRANTY

A. Provide two-year warranty from time of substantial completion for polyurethane sealants. Include coverage for installed sealants which fail to achieve watertight seal, exhibit loss of adhesion or cohesion, and sealants which do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

   1. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Colors of Exposed Joint Sealants: gray, unless selected by Architect from manufacturer's full range.

2.03 POURED JOINT SEALANTS

A. Parking Lot Pavement, Longitudinal and Transverse Joints:
1. Products:
   a. Bemac, Div. of McAsphalt; Beram 195/195LM.
   b. CRAFCO; ROAD SAVER 231.
   c. Koch Pavement Solutions; Koch Product #9030
   d. Maxwell Products, Inc.; Elastoflex 71.
   e. P.T.Products; DURA FILL 3405 LM.
   f. W.R.Meadows; 3405 Modified (Hot Pour)
   g. WRM SOF SEAL (2Comp. Cold Pour)
   h. Or equal specifically approved by engineer.

B. Expansion Joints in Walks and Parking
2. Products:
   a. Sonneborn Products; Sonolastic SL-1. Color gray.
   b. Or equal specifically approved by engineer.

2.05 EXPANSION JOINT FILLERS

A. Non-Linear Expansion Joints
   1. Polyethylene closed cell foam expansion joint filler. BASF, Sonoflex F.
   2. Only allowed at small curved joints, such as bollards or roof drain downspouts.
   3. Or equal specifically approved by engineer.

B. Linear Expansion Joints
   1. Resilient joint fibrous expansion board joint filler. Formflex Expansion Joint.
   2. Or equally specifically approved by engineer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Timing: Unless otherwise provided, before any portion of the pavement is opened to the Contractor's forces or to general traffic, expansion joints and sawn joints shall be sealed.

B. Cleaning:
1. Before sealing joints narrower than 3/8 inch, the residue from sawing shall be cleaned from the crack. Dry sawing residue shall be blown from the joint. Wet sawing residue shall be flushed away by high pressure water blast cleaning.
2. For joints 3/8 inch wide or wider, sand cleaning shall be used. When the joint surfaces appear dry by visual examination, the upper 3/4 inch of each joint face shall be cleaned by sand blast methods, followed by joint cleaning with air blasting. Air compressor shall provide moisture and oil-free compressed air. The angle of approach of the sand blast nozzle to each vertical face of the reservoir shall be approximately 30 degrees and the sand blast nozzle must have a guide which inserts in the joint and assures positive location and directional control of the nozzle.
3. Joint Sealer:
   a. Joint sealer shall be prepared and installed in the joint and to the proper level as shown in the contract documents and as recommended by the manufacturer.
   b. Hot-poured sealers shall be heated in a thermostatically controlled heating kettle; the material shall be heated to the temperature required for use, but not above that recommended by the manufacturer. After sealing, excess sealer shall be removed from the pavement surface.
   c. Joint sealer shall be placed only when the pavement and ambient air temperatures are 40 degrees Fahrenheit or higher. When near this minimum, additional air

blasting or drying time or both may be necessary to assure a satisfactory bond to the joint surfaces.

d. When this sealer cannot be properly placed due to late fall work, the Contractor shall submit a joint construction plan and sealing details to the Jurisdictional Engineer for approval before paving can begin.

e. Joints shall be sealed the same day they are cleaned. Sealing shall be done only when the joint surfaces appear dry by visual examination.

f. Where a curb does not exist, the joint opening at the pavement edges shall be sealed with tape.

g. If surface correction required the joints may need to be recleaned and resealed.

C. Install backer materials to support sealants during application and at position required to produce optimum sealant movement capability. Do not leave gaps between ends of backer materials. Do not stretch, twist, puncture, or tear backer materials. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants at the same time backings are installed to completely fill recesses provided for each joint configuration and to produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pavement Markings.

1.02 DESCRIPTION OF WORK

A. For marking of completed pavement surfaces.

1.03 SUBMITTALS

A. Minimum of two weeks prior to commencing any pavement marking operations, the Contractor shall submit a manufacture's catalogue sheet for each type of pavement marking paint used for review and approval by the Engineer.

1.04 SCHEDULING AND CONFLICTS

A. Construction Sequence:
   1. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
   1. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

C. Conform to Local, State and Federal Requirements.

1.05 RESTRICTIONS ON OPERATIONS

A. Surface Temperature Restrictions: Pavement markings shall not be placed when the temperature of the pavement surface is less than 40 degrees Fahrenheit, or between October 15th and April 1st.

PART 2 PRODUCTS

2.01 Waterborne Paint

A. The paint shall be capable of being heated and sprayed applied up to a temperature of 140° F without damaging the formulation or serviceability of the paint. The paint shall be free from heavy metals as defined by the U.S. EPA.

B. Pigment Content: The percent pigment by weight of the finished product shall be from 45% to 55% by weight for white and 55% to 58% for yellow paint as tested by ASTM D 3723.

C. Resin Solids shall be composed of 100% acrylic emulsion polymer.

D. Nonvolatile Vehicle: The nonvolatile vehicle shall not be less than 43% by weight for white paint and not less than 45% by weight for yellow paint.

E. Volatile Organic Compounds: Volatile organic compounds shall not exceed 1.25 pounds per gallon excluding water and VOC exempt solids. ASTM D 3960 shall be used to determine the levels of VOCs.

F. Density: The density shall be a minimum of 12 pounds per gallon and the density of the production batches shall not vary more than +/- 0.2 pounds.

G. No-Pick-Up Time: The no-pick-up time for the paint shall be less than 5 minutes.

PART 3 EXECUTION

3.01 CLEANING AND PREPARATION OF PAVEMENT

A. The pavement surface shall be dry and free from dirt, dust, oil and other contaminates which may interfere with the paint from properly bonding to the surface. The clean surface shall be at least 1 inch wider than the anticipated marking. An air blast shall occur immediately prior to the new marking being placed. The air blast is not intended to remove large amounts of dust or dirt, but only a small amount of residue that might be left after the cleaning operation.

3.02 UNIFORM APPLICATION

A. All painted markings shall have uniform thickness and width. The width of the lines shall be as specified with a tolerance of +/- ¼ inch for 4-inch lines and +/- ½ inch for wider lines.

B. The wet film thickness of the paint shall be 14 mils, used at a rate of 305.5 ft. of solid 4” line per gallon of paint.

3.03 TRAFFIC CONTROL

A. Traffic control shall remain in place from the time cleaning operations have started through the completed curing time of the newly applied paint markings.

3.04 MARKING REQUIREMENTS

A. Parking Stalls:
Solid yellow lines, 4 inches wide by length dimensioned on plans and shall be placed for each parking stall as shown in the plans. The spacing shall be nominally 9.5 feet on center, or as otherwise specified on plans.

B. Symbols and Stop Bars:
Symbols, directional arrows, and stop bars shall be painted yellow. Size and shape shall follow the Manual of Uniform Traffic Control Devices. Locations as shown in the plans.

C. Handicap Access Symbols and Aisles:
Symbols, painted yellow, a minimum of 5 feet in height, shall be placed as shown in the plans. Access aisles shall be painted color per plan with a diagonal stripe pattern, lines placed 2 feet apart on center.

D. Loading Zones:
Solid yellow lines 4” wide shall be placed as shown in the plans for loading zones. The lines shall be placed diagonally, spaced 2 feet on center. A solid yellow line shall outline the area on the pavement and on the curb.

END OF SECTION

SECTION 32 91 19

LANDSCAPE GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Final grade topsoil for finish landscaping shown on Landscape Drawings.

1.2 RELATED SECTIONS:

A. EARTHWORK: SECTION 31 20 00

PART 2 PRODUCTS

2.1 MATERIALS:

A. Topsoil: Fertile, friable loam, capable of sustaining vigorous plant growth, from well drained site free from flooding, not in frozen or muddy conditions; reasonably free from subsoil, clay lumps, roots, grass, weeds, stones larger than three-quarter (3/4) inch (19 mm) diameter, and foreign matter; acidity range (pH) of 5.5 to 7.5; containing minimum 4 percent and maximum 20 percent organic matter.

PART 3 EXECUTION

3.1 EXAMINATION:

A. Verify building and trench backfilling has been inspected.

B. Verify subsoil base has been contoured and compacted.

3.2 SUBSOIL PREPARATION:

A. Eliminate uneven areas and low spots.

B. Remove debris, roots, branches, and stones in excess of 1/2 inch (13 mm) in size. Remove subsoil contaminated with petroleum products.

C. Scarify subgrade to depth of 3 inches (75 mm), where topsoil is to be placed. Scarify areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.3 PLACING TOPSOIL:

A. Place topsoil in areas to be seeded or sodded and planted, to thickness as scheduled (Paragraph 3.6).

B. Use topsoil in relatively dry state. Place during dry weather.

C. Fine grade topsoil eliminating rough and low areas. Maintain levels, profiles, and contours of subgrade.

D. Remove roots, weeds, and foreign material while spreading.

E. Manually spread topsoil close to building to prevent damage.

F. Lightly compact placed topsoil.

H. Leave site clean and raked, ready to receive seeding or sodding and landscape planting.

3.4 TOLERANCES:

A. Top of Topsoil: Plus of minus 1/4 inch (6 mm).

3.5 PROTECTION:

A. Protect landscaping and other features remaining as final work.

B. Protect existing structures, walls, sidewalks, and paving.

3.6 IMPORTING TOPSOIL:

A. Use topsoil stockpiled during site stripping for respread.

B. If contractor finds stockpiles have insufficient quantity for respreads requirements, topsoil must be imported to site and included in bid.

3.7 SCHEDULE OF TOPSOIL DEPTHS:

A. The following paragraphs identify compacted topsoil thickness for various locations.
1. Ornamental Grass Planting Beds: Minimum 12 inches
2. Native Plants and Grass Areas: Minimum 8 inches.
3. Shrub Beds: Minimum 8 inches .
4. Turf seeded and sodded Areas: Minimum 8 inches

END OF SECTION

SECTION 32 92 19

SEEDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including Bidding Requirements, General and Supplementary Conditions and Division I Specification Sections, apply to work specified in this Section.

1.02 WORK INCLUDED:

A. Preparation of seedbed, furnishing and installing fertilizer, seed and mulch, maintenance and guarantee for seeding disturbed areas in accordance with the site plan.

B. Provide all labor, materials, equipment and supervision required to install turf seeding of lawns grass areas.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. EARTHWORK: SECTION 31 20 00.

B. LANDSCAPE GRADING: SECTION 32 91 19

1.04 DEFINITIONS

A. Finish Grade: Elevation of finished surface of topsoil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing rough grading, or top surface of a fill or backfill immediately beneath topsoil.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product certificates.

C. Planting Schedule: Indicating anticipated planting dates.

1.06 DELIVERY, STORAGE, AND HANDLING

A. If seed is mixed prior to delivery on the site, it shall be tagged showing a guaranteed statement of composition of mixture and percentage of purity and germination of each variety.

B. If seed is to be mixed at the site, it shall be delivered in original containers bearing producers certification of germination and purity.

C. Tags shall show producers or dealers Iowa Permit Number and date of testing; test date shall be no more than 90 days previous to time of use.

D. Fertilizers shall conform to State of Iowa laws and regulations. If delivered in bulk, bills of lading or other labels shall be furnished to Landscape Architect or labels indicating analysis and weight information from each container shall be preserved and furnished to Landscape Architect within twenty-four (24) hours of application.

E. Handling of materials as recommended by manufacturer.

F. Store all packaged materials off ground and protect from moisture.

G. Storage of all materials in locations designated and approved by Owner

1.06 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

1.07 CODES, INSPECTIONS AND PERMITS:

A. The entire installation shall fully comply with all local and State laws and ordinances, and with all established codes applicable thereto.

1.08 SITE DISTURBANCES:

A. Take precautions to ensure that equipment and vehicles do not disturb or damage existing site grading, walks, drives, utilities, plants, etc.

B. Verify locations and depths of all underground utilities prior to excavation.

C. Repair and/or return to original condition any damage caused by Contractor at no cost to Owner.

1.09 JOB CONDITIONS:

A. Existing Utilities:
   1. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during this work.
   2. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

3. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
4. Provide minimum of 48-hour notice to Owner and Landscape Architect and receive written notice to proceed before interrupting any utility.

B. Protection of Persons and Property:
1. Barricade open excavations occurring as part of this work and post with warning lights.
2. Operate warning lights as recommended by authorities having jurisdiction.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by this work.

1.10 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than 60 days from date of Substantial Completion and will include:
1. Repair of eroded areas prior to acceptance.
2. Maintenance of a uniform mulch cover until acceptance.
3. Until final acceptance and approval is received, reseed or overseed, using seed mix originally specified, all seeded areas to produce uniformity.

B. Mow lawn as soon as top growth is tall enough to cut. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Mow at 3" or higher.

PART 2 PRODUCTS

2.01 SEED

A. All seed mixes shall be local ecotypes and be locally obtained from:

United Seeds Inc
1800 Dixon Ave Suite A
Des Moines, Iowa 50316
(800) 365-6674

and shall consist of the following:

1. Seed Mix 1: "Super Turf II" Mix
2. Seed Mix 2: "Super Shade" Mix
3. Seed Mix 3: "Low Grow Grass and Wildflower" Mix (see Section 39 92 19.12 – NATIVE SEEDING)

If an equivalent seed manufacturer and mixture is desired, seed must be approved by project engineer:
Bishop Engineering
3501 104th St
Urbandale, IA 50322
515-276-0467
Attn: David Bentz

All equivalent seed must also be Certified Blue Tag Seed.

2.02 PLANTING MATERIALS

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 3/4 inch or larger in any dimension and other extraneous materials harmful to plant growth.
   1. Topsoil Source: Reuse surface soil stockpiled on-site and supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Verify suitability of stockpiled surface soil to produce topsoil.

B. If necessary Inorganic Soil Amendments:
   1. Lime: ASTM C 602, Class T or O, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.
   2. Aluminum Sulfate: Commercial grade, unadulterated.

C. If necessary Organic Soil Amendments
   1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8.

D. Fertilizer:
   1. 6-24-24 Fertilizer shall be applied to all Type 1 Seeding areas

E. Mulch:
   1. Hydraulic Mulch: Wood cellulose hydraulic mulch with tackifier shall be applied at a rate of 2500lbs/acre.

PART 3 EXECUTION

3.01 LAWN PREPARATION

F. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Apply Superphosphate fertilizer directly to subgrade before loosening.
   2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
   3. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

G. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
   3. Remove stones larger than ¾” inch in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

H. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and

fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

I. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

J. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.02 SEEDING/ MULCHING

A. Seeding rates according to United Seed specifications or at rate as specified on Landscape plan, rate on Landscape Plan governs.

B. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.

C. Apply wood cellulose Hydraulic Mulch at rate of 2500 lbs/ acre.

3.02 FERTILIZING

A. Fertilize all seed type I areas with product specified above at rate of 250 lbs/ acre.

3.03 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches.

B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

END OF SECTION

SECTION 33 31 00

SANITARY SEWERAGE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewer drainage piping, fittings, accessories and bedding.

B. Connection of project sanitary drainage system to the municipal sanitary sewer system.

C. Clean-out and access structures.

1.02 RELATED DOCUMENTS:

A. The Contract Documents, as defined in Section 01 11 00 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

1.03 RELATED SECTIONS:

A. Section 31 23 33, Trenching and Backfilling.

1.04 REFERENCES

A. American Association of State Highway and transportation Officials (AASHTO):
   1. AASHTO M294 - Corrugated Polyethylene Pipe, 300-1200 mm Diameter.
   2. AASHTO M252 - Corrugated Polyethylene Drainage Pipe.

B. American National Standards Institute (ANSI):
   1. ANSI A21.14 - Ductile Iron Fittings, 3-Inch Through 24-Inch, for Gas.

C. American Society for Testing and Materials (ASTM):
   1. ASTM C 12 - Practice for Installing Vitrified Clay Pipe Lines.
   2. ASTM C 14 - Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   3. ASTM C 76 - Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   4. ASTM C 425 - Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
   5. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   6. ASTM D 3034 - Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
   7. ASTM A 746 - Specification for Ductile Iron Gravity Sewer Pipe.
   8. ASTM C 700 - Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and perforated.
   9. ASTM F 477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.05 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.06 SUBMITTALS

A. Section 01 35 16 – Alteration Project Procedures: Procedures for submittals.
   1. Product Data: Data for each type of pipe and pipe accessory specified.

B. Section 01 78 00 - Closeout Submittals: Procedures for closeout submittals.

1. Project Record Documents: Accurately record the following.
   a. Actual locations of pipe runs, connections, manholes, cleanouts, and invert elevations.
   b. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.07 QUALITY ASSURANCE

A. Regulatory Requirements: Perform work in accordance with utility company requirements and applicable health codes and authority having jurisdiction requirements.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. All pipe and materials shall comply with the local jurisdiction's Plumbing Code and SUDAS.

B. Ductile Iron Pipe:
   1. Pipe: Class 52, conforming to AWWA C151/ANSI A21.51, inside nominal diameter as indicated on Drawings with bell and spigot end.
   2. Pipe Joint: AWWA C111/ANSI A21.11, rubber gasket joint devices.

C. Solid Wall Polyvinyl Chloride Pipe (PVC) 8 inch to 15 inch:
   1 Comply with ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness solid wall pipe, SDR 23.5 (153 psi), 26 (115 psi), 35 (46 psi).
   2 PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
   3 Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

D. Solid Wall Polyvinyl Chloride Pipe (PVC) 18 inch to 27 inch:
   1 Comply with ASTM F 679. Minimum pipe stiffness of 46 psi as per ASTM D 2412.
   2 PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
   3 Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

E. Polyvinyl Chloride Composite Pipe (truss type PVC) 8 inch to 15 inch:
   1 Comply with ASTM D 2680 (composite pipe), minimum pipe stiffness 200 psi. Pipe constructed with truss-type structure between inner and outer PVC walls with voids filled with lightweight concrete.
   2 PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.

2.02 PIPE ACCESSORIES

A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

B. Fittings: Mechanical Joint Cast Iron Fittings.

C. Trace Wire: Refer to Section 31 23 33 Part 3.11 for general tracer system requirements.

D. Pipe Markers: Aluminum Foil core for non-ferric metal detectable conductor, clear brightly colored plastic covered, imprinted with "SEWER SERVICE" in large letters.

E. Protect all ductile iron pipe and fittings with 8 mil polyethylene wrap conforming to AWWA C105/ANSI A21.5.

2.03 CLEANOUTS AND MANHOLES

A. Lid and Frame: Heavy duty cast iron with removable lid as indicated on Drawings.

B. Shaft Construction: Cast Iron shaft of internal diameter as indicated on Drawings with 3500 psi concrete collar for cleanouts.

C. Manhole pipe connections shall include flexible, watertight gasket cast integrally with barrel sections per ASTM C923.

PART 1 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.
1. Verify trench cut, excavations, dimensions, and elevations are as indicated on Drawings.

B. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.03 BEDDING

A. Excavate pipe trench and place bedding material in accordance with Section 31 23 33 for work of this Section.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches compacted depth, each layer. Place compacted bedding material to elevation of paving subgrade as indicated on Drawings.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

D. Remove excess backfill and excavated material from site.

3.04 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM C 12, ASTM C 14, manufacturer's published instructions and state or local requirements. Seal joints watertight.

B. Install pipe on minimum 4 inch bedding as specified in Section 31 23 33.

C. Lay pipe to slope gradients indicated on Drawings.

D. Refer to Section 31 23 33 for trenching requirements. Do not displace or damage pipe when compacting.

E. Connect to building sanitary sewer outlet and municipal sewer system as indicated on Drawings.

F. Refer to Section 31 23 33 Part 3.11 for general tracer system requirements.

3.05 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to elevation indicated on Drawings.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe to be placed at required elevations.

C. Mount lid and frame level in grout, secured to top section at elevation indicated.

3.06 SERVICE CONNECTIONS

A. Coordinate the Work with termination of sanitary sewer connection outside building including connection to municipal sanitary sewer system.

B. Connect to existing municipal sanitary sewer system in compliance with utility requirements for new service connections.

3.07 FIELD QUALITY CONTROL

A. Site Tests:
   1. Perform inspections prior to and immediately after placing bedding.
   2. Compaction: Specified in Section 31 23 33.
      a. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.
      b. Frequency of Tests: One test for each 50 lineal feet of trench.
   3. Perform the following tests in accordance with applicable local Public Works Department Standard Specifications and requirements.
      a. Pressure Test.
      b. Infiltration Test
      c. Deflection Test

END OF SECTION

SECTION 33 31 01

SANITARY SEWER MANHOLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Manholes for sanitary sewers.

B. Adjustment of existing manholes.

C. Connection to existing manholes.

D. Abandonment of manholes.

E. Existing Manhole Rehabilitation

1.02 DESCRIPTION OF WORK

A. Construct sanitary and storm sewer manholes, modify existing manholes, and abandon manholes where shown in the Plans.

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings showing compliance with this Specification.

C. Shop drawing schedule of new manholes showing total depth, relative elevations of all connecting sanitary or storm sewer lines, all drops, and orientation of connecting lines.

D. Catalog cuts of iron castings and sewer line connection gaskets.

E. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

C. Precast sections meeting the requirements of ASTM C 478.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete elements of the work which can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and Federal requirements.

C. Sanitary Manholes and Castings:

1. Manhole Types:

Type	Description	Main Pipe Size	Typical Depth	Figure No.
A	48" Min. Dia. Barrel with Eccentric Cone and Integral Precast Base	See Table for Max. Dia. Pipe	No Limit	
E	Poured-in-Place Box	18" or Greater Dia. Pipe	6' - 12'	
F	Combination Poured in Place Manhole with 48" Dia. Riser and Eccentric Cone	18" or Greater Dia. Pipe	12' - 22'	
I	48" Dia. Barrel with Eccentric Cone and Poured in Place Base for Manhole Placement on Existing Sewer	18" Max. Dia. Pipe without Engineer Approval	No Limit	
J	48" Dia. Barrel with Eccentric Cone and T-Section	42" Dia. or Greater Eccentric Reducer Required	8.5' Min.	

2. Ring and Cover Types:

Type	Ring & Cover	No. of Pieces	Bolted Frame	Bolt Cover	Gasketed	Figure No.
A	Standard*	2	Yes	No	Yes	
B	Adjustable**	3	No	No	Yes	
C	Standard*	2	Yes	Yes	Yes	
D	Adjustable**	3	No	Yes	Yes	

* Use when placed in earth fill, asphalt pavement, or ACC manhole boxout.
** Use when placed in PCC pavement or PCC manhole boxout.

1.08 MEASUREMENT FOR PAYMENT

All measurements for payments will be made by the Engineer or authorized representative.

A. Manhole: For each type and size of manhole required and furnished, measure manhole vertical dimension in feet from the flow line to the top of the ring casting. Payment shall be at the unit bid price for each type and size of manhole properly installed. The unit bid price for manholes shall include all bedding, backfill, compaction and all appurtenances including castings and lids necessary for the proper installation.

B. Drop Connection: Measure vertical feet of drop, from the flow line of the incoming sewer to the flow line of the drop at its entry into the manhole, for each size of sewer line. Payment shall be at the unit bid price for vertical feet of drop per size of sewer line.

C. Manhole Adjustment, Minor: Removal or addition of Manhole adjusting rings are considered an incidental item to manholes, unless otherwise specified as a pay item in the contract documents. If specified as a pay item, it shall be at the unit price bid for each adjustment. If so specified, count the number of manholes adjusted to finished grade by raising or lowering an adjustable casting or by addition or removal of manhole adjusting rings.

D. Manhole Adjustment, Major: Count the number of manholes adjusted to grade by addition or removal of manhole barrel, cone or flat top sections, or the exchange of existing sections with sections having revised vertical dimensions. Count separately the cast in place manholes that will require removal of concrete to accommodate adjustment. Payment shall be at the bid price for each major adjustment.

E. Connection to Existing Manhole: Count the number of connections made to existing manholes. Payment shall be at the unit bid price for each connection.

F. Abandoned Manhole: Count the number of manholes abandoned in place. Payment shall be at the unit bid price for each abandoned manhole. (NOTE: Refer to Section 6020, 3.05 for removal of manholes.)

PART 2 - PRODUCTS

2.01 MANHOLES

A. Placement: Conform to elevations, locations and connection orientations shown on the Plans and detailed drawings.

B. Barrel Diameter, Inside: For sewers up to 24-inch size with two connections use 48 inches diameter barrel or as shown in the contract documents. For larger sewers or more connections,

see Plans and detailed drawings.

C. Wall Thickness: See Detail Plates

D. Coating: Exterior: when exterior waterproof coating is specified, provide bituminous or coal tar coating.

E. Top Configuration: Eccentric top except as noted on the Plans or detailed drawings. Total manhole depth 6 feet or more use cone top section. Total manhole depth less than 6 feet use minimum 9" thick flat top.

F. Joints, Barrel: Male and female ends.
1. Seals, rubber 'O' ring or profile gasket, flexible joint, per ASTM C 443.
2. Apply Bituminous joint compound or butyl sealant wrap meeting ASTM C 877 to all exterior joints.
3. Provide tapered rubber lift hole plug manufactured of SBR with a minimum tensile strength of 800 psi and 80 durometer + or –5.
4. Provide non-shrink grout to cover lift hole plug and to fill interior joints.

G. Concrete: Precast: Comply with ASTM C 478.

H. Base: Precast manhole: Integral base and riser section in accordance with ASTM C 478.

I. Pipe Connection:

1. New Sanitary Sewer Manhole:

   a. Flexible, watertight gasket per ASTM C 923 cast integrally with riser section(s).
   b. Drop connection where required on Plans. See also Detailed Drawings.
   c. When specified, coat interior per 4010, 2.01 F, 5, 6, 8, 9, 10.
   d. Grout internal joint space: non-shrink grout.

2. Existing Sanitary Manhole:

   a. Cored or drilled opening: Provide a flexible, watertight connection that meets and/or exceeds ASTM C 923.
   b. Knock out opening:
      1) Provide a watertight connection (waterstop or other method), meeting the material requirements of ASTM C 923, that is securely attached to the pipe with stainless steel bands or other means.
      2) Grout opening in manhole wall with non-shrink grout.
      3) Pour concrete collar around pipe and outside manhole opening.
      4) Provide flexible pipe joint or flexible connector within 2' of collar.

J. Manhole Steps: None, unless required on the Plans. If required, space steps at 12 to 16 inches, comply with ASTM C 478. Align with vertical side of eccentric cone top section.

2.02 MANHOLE ADJUSTMENT RINGS (Grade rings)

A. All grade adjustments of manhole frame and cover assemblies shall be completed utilizing one of the following:

1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and be free from cracks, voids and other defects. Concrete rings will be set with asphalt mastic.

2. High Density Polyethylene Grade Adjustment Rings: Comply with ASTM D 1248 for recycled plastic.

   a. Material properties shall be tested and certified for usage by the following ASTM methods:

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g / 10 min.
Density	ASTM D 792	0.94 to 0.98 g / cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 lb / in^2

   b. Polyethylene adjusting rings shall not be used when they are exposed to heated hot mix asphalt pavement.
   c. Tapered configuration: When used in a single configuration tapered adjusting ring thickness will range from 0.5 inch to 3.0 inch.
   d. Grade adjustment rings are to be installed on clean flat surfaces according to the manufacturer's recommendations with the proper Butyl Rubber sealant/adhesives.

B. The inside diameter of the adjustment ring shall not be less than the inside diameter of the manhole frame.

C. Manholes shall be constructed with at least two adjustment rings.

D. Maximum height of adjustment ring stack: 12 inches max. for new manholes and 16 inches max. on existing manholes.

2.03 CASTINGS (Ring and Cover)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Sanitary Sewer Manhole Ring and Covers:

1. Refer to Plans for locations of types.

2. Machined bearing surfaces.

3. All covers must be gasketed.

4. Grassed areas not subject to flooding: Type A.

5. Grassed areas subject to flooding, bolted down cover: Type C.

6. Paved areas, sidewalks, and areas subject to vehicular traffic and not subject to flooding or in sloped paved areas use cover: Type B.

7. Paved areas, sidewalks, and areas subject to vehicular traffic and flooding or in sloped paved areas subject to flooding, use bolted down cover: Type D.

2.04 CHIMNEY SEAL (Required on all Sanitary Sewer Manholes)

A. External Seal:

1. Rubber Sleeve and Extension:
   a. Corrugated, minimum thickness of 3/16 inches, per ASTM C 923.
   b. Minimum vertical unexpanded length of 6 and 9 inches with allowable vertical expansion of at least 2 inches.
   c. Top section of sleeve shall contain multiple sealing fins to extend both over and under the manhole frame's base flange. Bottom section of sleeve shall contain an integrally formed compression band recess with multiple slaking fins.
   d. Top section of extension to be shaped to fit into the bottom band recess of the sleeve. Bottom section of extension shall contain an integrally formed compression band recess with multiple sealing fins.

2. Compression Bands:
   a. One piece band assembly to compress sleeve or extension against manhole surface.
   b. Material 16 gauge ASTM A 240 Type 304 stainless steel, minimum 1 inch width, minimum adjustment range of 4 diameter inch.
   c. Top band shaped to lock sleeve to manhole frame's base flange.
   d. Stainless steel fasteners, ASTM F 593 and 594, Type 304.

B. Internal Seal:

1. Rubber sleeve and extension:
   a. Double pleated, minimum thickness 3/16 inch thick, per ASTM C 923.
   b. Minimum vertical unexpanded length of 8 and 10 inches with allowable vertical expansion of at least 2 inches.
   c. Integrally formed expansion band recess top and bottom with multiple sealing fins.
   d. Top section of extension shaped to fit bottom band recess of the sleeve. Bottom section of extension shall contain an integrally formed expansion band recess with multiple sealing fins.

2. Expansion Bands:
   a. One-piece band assembly to compress sleeve or extension against manhole surfaces.
   b. Material 16 gauge ASTM A 240 Type 304 stainless steel, minimum 1 3/4 inch width, minimum adjustment range of 2 inches.
   c. Locking mechanism of studs and nuts used to be stainless steel conforming to ASTM F 923 & 594, Type 304.

2.05 INVERT: Poured in place concrete. Shape to provide a smooth transition between pipe inverts. Bring manhole invert up to one half of pipe diameter to produce a half pipe shape. Slope invert bench toward pipe 1/4 inch per foot perpendicular to flow line.

PART 3 - EXECUTION

3.01 MANHOLE INSTALLATION

A. Manhole Chimney

1. Install internal or external rubber chimney seal in accordance with Section 6020, 3.04.

2. Aromatic Flexible Urethane Seal:

a. Surface Preparation shall be in accordance with the manufacturer's recommendations and shall include sandblasting, pressure washing, sealing leaks or gaps, and drying surface.
b. Apply primer, prepare product and apply in accordance with manufacturer's recommendations.

B. Subgrade Preparation:

1. Undisturbed soil: Hand grade to accurate elevation.

2. Disturbed soil: Machine compact to 95 percent of Standard Proctor Density and hand grade to accurate elevation or install stabilization material as directed by Engineer.

C. Installation of Poured In Place Base: Sanitary sewers: embed base riser in base slab 3 inches, minimum. Assure proper vertical and horizontal alignment of base riser section.

D. Installation of Precast Base with Base Riser: Assure proper vertical and horizontal alignment of base riser section.

E. Additional Risers: Install additional riser sections as required. Grout inside face of joints.

F. Repair: Repair any honeycomb areas or damaged areas as directed by Engineer.

G. Backfill up to pipe grades. Connect and bed pipes using bedding material up to one foot above top of pipes.

H. Sanitary sewers: Grout inside pipe/manhole joint. Install rubber plug and grout over manhole lift holes.

I. Install manhole invert. Remove any projections and repair any voids to assure a hydraulically smooth channel between pipe ends.

J. Install manhole top slab or cone.

K. Install manhole adjustment rings. Bed each ring with cold-applied bituminous jointing compound. Do not install more than total ring stack height of 12 inches. For greater adjustment, modify barrel riser section(s).

L. Install manhole ring and cover. Adjust accurately to proper grade. Where manhole is to be in a paved area, adjust slope to match finished surface.

M. Install chimney seal: Install chimney seal per manufacturer's recommendations on sanitary sewer manholes.

N. Seal Manhole Joints: Apply bituminous joint compound or butyl sealant wrap to exterior of sanitary sewer manholes joints.

O. Backfill and compact. Refer to Section 2322. Use extra care to assure proper and uniform compaction of backfill around structure.

3.02 MODIFICATION OF EXISTING MANHOLES

A. Minor Adjustment: adjustment by adding or removing adjusting rings:

1. Add adjustment rings if necessary, up to a total ring stack height of 16 inches to adjust existing manhole to finished pavement grade or finished topsoil grade. Bed each ring with cold applied bituminous jointing material.

2. Remove one or more adjustment rings, as appropriate to reduce casting elevation.

3. Replace castings. Install new frame and cover for manholes located within new full depth pavement: use adjustable frame and cover as specified.

4. Replace chimney seal for sanitary sewer manholes using only new materials.

5. Refer to Section 2751 and 2741 for additional manhole adjustment requirements in pavement.

B. Major Adjustment: adjustment by adding or removing barrel or cone sections

1. Remove castings.

2. Remove top.

3. Modify barrel riser or modify type of top section, as appropriate, or both.

4. Replace castings. Install new frame and cover for manholes located within new full depth pavement. Use an adjustable frame and cover as specified.

5. Replace chimney seal for sanitary sewer manholes using only new materials.

C. Connection to Existing Manhole: Unless otherwise specified in the contract documents, or approved by the Engineer, all new openings in existing manholes shall be cored.

1. Excavate as appropriate. Mark manhole barrel for point of insertion of added sewer line.

2. Divert flow as necessary. Maintain sewer service at all times unless otherwise permitted by Engineer.

3. Carefully cut and chip or core out opening to manhole. Remove existing manhole invert as necessary to install pipe at required elevation and develop hydraulic channel.

4. Cored opening:
   a. Insert flexible watertight connector into new opening.
   b. Install and tighten internal expansion sleeve to hold flexible connector in place.
   c. Insert pipe through flexible connector and tighten external compression ring.
   d. Do not grout opening or pour collar for cored opening with flexible connector.

5. Cut and chipped opening (knockout): When allowed, refer to Figure 6020.21
   a. Install waterstop around outside of pipe. Secure in place.
   b. Position end of pipe flush with interior wall of manhole and with waterstop located within wall opening.
   c. Grout opening between manhole wall and outside of pipe with non-shrink grout.
   d. Pour concrete collar around pipe and exterior manhole opening.

6. Reconstruct manhole invert.

7. Bed pipe and backfill per Section 2322.

3.03 CHIMNEY SEALS (Required on All Sanitary Sewer Manholes)

A. Install internal chimney seal if manhole is to be under pavement or, if not under pavement, is set more than 3 inches above final grade or subject to movement.

B. Install external chimney seal if manhole is not to be under pavement except as noted in 3.04 A.

C. Install seals on a smooth sealing surface. Seals to extend from the flange of the manhole frame to 3 inches below the adjusting ring, use multiple seals, if necessary. Install compression bands (external chimney seal) or expansion bands (internal chimney seal) to lock the rubber sleeve or extension into place and to provide a positive watertight seal. Once tightened lock into place. Use only manufacturer recommended installation tools and sealants.

3.04 ABANDONED MANHOLES

A. Remove top and walls of structure to a minimum of 10 feet below subgrade in paved areas or 10 feet below finish grade in other areas.

B. Plug all pipes in structure using 3,000 psi concrete.

C. Fill remaining structure using flowable mortar.

D. Place compacted earth fill over structure as required for embankment or compacted backfill.

END OF SECTION

SECTION 33 40 00

STORM SEWER AND DRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Storm Sewers.

B. Subdrains.

C. Footing Drain Sewer Collectors.

D. Storm Sewer Service.

1.02 DESCRIPTION OF WORK

A. Construct storm sewers, subdrains, and footing drain collectors.

B. Construct storm sewer service and connections.

C. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2012, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Manufacturer′s instructions for installation of pipe and appurtenances.

C. Construction sequence.

D. Catalog cuts, samples, manufacturer′s data, and listing of applicable standards for special, unique, or proposed substitute materials if requested by Engineer.

E. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.

F. Project Record Documents.

G. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store materials and handle to avoid damage. Replace any damaged materials. Remove damaged materials from site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:
1. Attend a preconstruction meeting if required by Engineer.
2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations, and verify clearance for proposed construction.
2. Complete elements of work that can affect line and grade in advance of storm sewer construction unless noted on plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state and federal requirements.

1.08 MEASUREMENT FOR PAYMENT

A. All measurements for payments will be made by the Engineer or authorized representative.

B. Storm Sewers and Subdrains:
1. Measurement of pipe, except aprons, will be in linear feet along centerline of pipe in place.
2. Measurement of each size and type of pipe installed will be from end of pipe to end of pipe.
3. Payment will be made at the unit bid price for each size and type installed.

C. Incidental Items:
1. Items that are not listed as specific bid items, but are required for proper completion of the work, are incidental to construction. Pipe testing is incidental.
2. Incidental items may or may not be shown on plans.
3. No payment shall be made for incidental items.

PART 2 - PRODUCTS

2.01 STORM SEWERS

A. Reinforced Concrete Pipe (RCP):
1. Conform to ASTM C 76.
2. Minimum Class III, Wall B.
3. Tongue and groove joints.
   a. Use cold applied bituminous jointing materials, unless otherwise specified.
   b. If specified, use rubber O-ring flexible joint conforming to ASTM C 443.
4. If specified, wrap exterior of each joint with engineering fabric.

E. Polyvinyl Chloride Pipe (PVC):
1. Use pipe conforming to the following:
   a. Minimum pipe stiffness of 46 psi.
   b. ASTM F 949, corrugated exterior, smooth interior; ASTM D 3034, solid wall PVC; ASTM F 679, solid wall PVC (up to 27 inches).
   c. Gasketed integral bell and spigot joints per ASTM D 3212 and ASTM F 477.

2. Do not use in right-of-way.
3. Use only outside of right-of-way in public utility easement areas where no utilities exist or are proposed (running parallel or crossing) or where the trench for the PVC pipe will not be disturbed, and where the Engineer allows.

F. High Density Polyethylene (HDPE): N-12 PIPE: PIPE SHALL BE ADS N-12 MEGA GREEN.
1. Pipe shall consist of smooth interior and annular exterior corrugations.
2. 4- through 10-inch (100 to 250 mm) shall meet ASTM F2648(virgin/recycled material) , Type S.
3. 12- through 60-inch (300 to 1500 mm) shall meet ASTM F2648 (virgin/recycled resins), Type S.
2. Use only fittings supplied or recommended by pipe manufacturer for soil tight service.
3. Only use outside of Public Right of Way where allowed by jurisdiction.

G. Bituminous Jointing Material:
1. Use with RCP, RCAP, and RCEP, unless indicated otherwise on plans.
2. Use a cold applied mastic sewer joint sealing compound recommended by the manufacturer for the intended use and approved by the Engineer. Supply in either rope form or flat type form or suitable for trowel application. Meet the requirements of AASHTO M 198.

H. Bituminous Joint Primer: Meet the requirements of ASTM D 41, which is intended for use in priming concrete pipe joints prior to application of bituminous jointing material.

I. Engineering Fabric**:**
1. Use for wrapping exterior of storm sewer pipe joints where indicated on plans.
2. Use Iowa DOT 4196.01B fabric for use in subsurface drains.

J. Reinforced Concrete Apron:
1. Use where indicated on plans.
2. Use pipe conforming to ASTM C 76.
3. Strength not less than adjoining pipe sections.

K. Apron Guard:
1. Use where indicated on plans.

2.02 SUBDRAINS

A. Polyvinyl Chloride Pipe and Fittings (Solid Wall PVC):
1. Conform to ASTM D 3034, minimum thickness SDR 35, 46 psi minimum pipe stiffness.
2. PVC plastic according to ASTM D 1784, Cell Classification 12454.
3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.
4. Fabricated or preformed saddle wye or saddle tee for service tap conforming to AASHTO M 252 or M 294.
5. Slot subdrain pipe according to ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.

B. Polyvinyl Chloride Corrugated Pipe and Fittings (Corrugated PVC):
1. Corrugated exterior, smooth interior, PVC.
2. Conform to ASTM F 949, minimum pipe stiffness, 46 psi.
3. PVC plastic according to ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.
5. Slot subdrain pipe according to ASTM F 949.

C. Polyethylene Corrugated Tubing (Corrugated PE):

1. Conform to AASHTO M 252, Type C, corrugated interior and exterior or Type S, corrugated exterior, smooth interior.
2. Use only fittings supplied or recommended by pipe manufacturer for soil tight service.
3. Perforated with slots conforming to AASHTO M 252, Type CP, or Type SP.

D. Aggregate Backfill: Conform to State of Iowa Department of Transportation Standard 4131, Porous Backfill Material; Crushed stone or gravel meeting Iowa DOT Gradation No.29.

E. Engineering Fabric: Use fabric conforming to Iowa DOT 4196.01B.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify measurements at site; make necessary field measurements to accurately determine pipe makeup lengths or closures.

B. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

3.02 LINE AND GRADE

A. Install pipe to line and grade shown on plans. Set field grades to invert of pipes or culverts.

B. Notify Engineer immediately if discrepancies or irregularities are discovered in line or grade shown by grade stakes.

C. Make detailed measurements as required to construct work to line and grade established by line and grade hubs.

D. Batter Boards:
1. Set grade points at 25-feet intervals at convenient offset from centerline of pipe or culvert.
2. Set batter boards as necessary to construct to design line and grade.
3. Provide at least three batter boards at all pipe laying areas during construction as check on accuracy of grades.
4. Check line and grade of each pipe length with grade rod and plumb bob.

E. Laser Beam:
1. Set laser equipment to proper line and grade from line and grade hubs.
2. Check line and grade of laser at 25-feet intervals for first 100 feet and then at 50-feet intervals for each setup.
3. Check line and grade of each pipe length.

F. Correct Misalignment: Correct misalignment, displacement, or otherwise defective pipe by removing, relaying, or replacing pipe at Contractor′s expense.

3.03 PIPE INSTALLATION

A. Provide trench excavation, pipe bedding, and backfill as specified in Section 31 23 33.

B. Provide proper facilities for lowering the sections into place without damaging the pipe.

C. Begin at lowest point in line. Lay groove or bell end point upstream unless specifically noted otherwise.

D. Prepare trench bottom to design line and grade so only minor movement of pipe is necessary after installation.

E. Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.

F. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.

G. Do not lay pipe in water or on saturated soil or bedding. Do not allow water to rise in trench around pipe.

H. Place pipe with lifting holes at the top of the pipe and fill lift hole with non-shrink grout or manufactured plugs.

I. Lay pipe to design line and grade.

J. Provide uniform bearing for full pipe barrel length.
1. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
2. Do not block pipe above bedding.

K. Assemble joints as specified.

L. Protect exposed upstream ends of pipe to prevent soil sediment from entering storm sewer system with the watertight stopper, cap, or plug.

M. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.

N. Saw cut ends of pipe at manholes, intakes, and structures. Do not hammer cut or break pipe.

O. Provide manholes and intakes where indicated on plans and as specified.

3.04 PIPE JOINTING

A. Joint Cleaning: Clean joint surfaces with wire brush to remove soil or foreign material prior to jointing pipe.

B. Assemble Joints According to Pipe Manufacturer's Recommendations:
1. Use equipment that does not apply damaging forces to pipe joints.
2. Use bar and block or internal or external jointing devices or other methods recommended by pipe manufacturers.

C. RCP, RCAP, and RCEP:
1. Use cold applied bituminous jointing materials unless otherwise specified.
   a. Apply joint material to entire tongue or to top half of tongue and bottom half of groove, in sufficient quantity to fill joint; close joint between pipes.
   b. Fill remaining voids in joint both inside and outside of pipe with joint material; smooth joint material on inside of pipe 24 inches and larger.
2. If rubber O ring is specified, coat rubber ring gasket and joint with soap-based lubricant immediately prior to closing joint.
3. If wrapped pipe joint is specified,
   a. Secure engineering fabric in place to prevent displacement during backfill operations.
   b. For combination storm sewer/subdrain or Type II subdrain, do not use joint sealant.
4. Joint openings on the outside or inside of the pipe that do not exceed 1/8 inch at the bottom and 5/8 inch at the top are acceptable.

5. Fully encase large joint openings, unless required for camber, with a Type II concrete collar (see Figure 4020.1A). Use Class C structural concrete.

D. RCPP: Coat rubber ring gasket and joint with soap-based lubricant immediately prior to closing joint.

E. CMP and CMAP:
1. Install coupling bands that match ends of pipes.
2. End of coupling bands must lap or be fabricated to form tightly closed joint upon installation.

F. PVC Pipe and Corrugated PVC Pipe: Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.

G. High Density Polyethylene (HDPE): Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.

H. High Density Polyethylene (HDPE): N-12 MONSTER GREEN PIPE:
1. Fittings shall conform to ASTM F2648.
2. Joints shall be N12 ST IB (Soil Tight)
   a. Join pipes with bell & spigot joint meeting ATSM F2648.
   b. Soil Tight gaskets shall meet the requirements of ASTM F477.
   c. Gaskets shall be installed by pipe manufacturer and covered with removable wrap to ensure gasket is free of debris.
   d. Joint lubricant available from manufacture shall be used on the gasket and bell during assembly

I. Connections between Dissimilar Pipes:
1. Use manufactured adapters or couplings approved by Engineer.
2. Where adapters or couplings are not available, Engineer may authorize use of concrete collar.

3.05 PIPE END SECTIONS

A. Provide reinforced concrete or metal pipe aprons where indicated on plans.

B. Install footings with aprons according to figure, if required.

C. Anchor last three pipe sections and aprons together with two pipe connections per joint.

D. Install apron guard where indicated on plans.

3.06 SUBDRAINS AND TRENCH DRAINS

A. Provide subdrain where indicated on plans.

B. Provide trench drains where indicated on plans.

C. If specified, install engineering fabric.

3.07 FOOTING DRAIN COLLECTOR

A. Install footing drain collector per Section 31 23 33.

B. If specified, install engineering fabric.

C. Provide cleanouts and connections.

1. Connect footing drain sewer collectors to storm sewer manhole or intake.
2. Provide fabricated or preformed wye or tee service fitting for each platted lot or building.

D. Provide manholes, if specified.

3.08 STORM SEWER SERVICE STUBS

A. Provide storm sewer service connection and line from storm sewer or footing drain sewer for each platted lot or building as shown on plans.

B. Use fabricated or preformed saddle wye or saddle tee for service tap to storm sewers. Clamp with two stainless steel clamps and install according to the manufacturer′s recommendations.

C. Extend storm sewer service from storm sewer or footing drain collector to 10 feet outside of the right-of-way line or as shown on the plans.

D. Place watertight stopper or plug in end of storm sewer service.

3.09 TOLERANCES

A. Horizontal and vertical alignment of gravity sewer lines shall not vary from design line and grade at any point along the pipe by more than 1% of the inside diameter of the pipe or 1/4 inch, whichever is larger.

B. Tolerance allowed only if design line and grade is sufficient to prevent backslope when tolerance limits are reached.

C. Reverse slope on pipe is prohibited.

3.10 CONFLICTS

A. Provide temporary support for existing water, gas, telephone, power, and other utilities or services that cross trench.

B. Compact backfill under existing utility crossing as specified in 3123 33 or construct utility line supports where indicated on plans or as directed by Engineer.

3.11 STORM SEWER ABANDONMENT

A. When sewers are to be abandoned, standard sewer plugs shall be placed. Prior to placing the plug, ensure the line is not in use. If noted on the plans, fill the line with gravity flow or pump the line full of flowable mortar or controlled low strength material.

3.12 CLEANING

A. Clean all storm sewers by flushing with water and by removing sheeting, bracing, shoring, forms, soil sediment, concrete, or other debris as directed by Engineer prior to final acceptance.

B. Do not discharge soil sediment or debris to drainage channels or existing storm sewer or sanitary sewer systems.

PART 4 - TESTING

4.01 DESCRIPTION OF WORK

A. Test and inspect storm sewers, culverts, footing drain sewers and building storm sewers.

4.02 SCHEDULING

A. Notify Owner's Representative when installation is complete and ready for testing.

B. Notify Owner's Representative at least 24 hours prior to performing testing.

C. Owner's Representative must be present to review testing procedures and to record results.

4.03 TESTING EQUIPMENT

A. Conform with applicable sections of ASTM.

B. Conform to other applicable industry standards and codes.

4.04 VISUAL INSPECTION

A. Check each section of storm sewer by lamping.

B. Light should be visible through section of pipe lamped.

C. Visually inspect each section of pipe.

D. Repair or replace defective pipe or joints or remove and relay pipe not meeting alignment tolerances as directed by Engineer.

4.05 DEFLECTION TESTING

A. Perform deflection tests on all HDPE storm sewer pipe 12" diameter or greater.

B. Perform deflection tests after backfill has been in place at least 30 days and before paving activity takes place or as per appropriate sections of these specifications.

C. Pipe deflection shall not exceed 5% of average inside diameter as established by ASTM Standards.

D. Pull approved 9-arm deflection mandrel through sewer by hand.

E. Approved mandrel must conform to applicable ASTM Standards.

F. Remove and replace pipe exceeding deflection limits.

G. Handle and divert existing flows during deflection testing.

END OF SECTION

SECTION 33 49 00

STORM DRAINAGE STRUCTURES

SUBPARTS:

A. MANHOLES
B. INTAKES
C. CAST-IN-PLACE
D. NYPLOPLAST INTAKE SUBSTITUTES

A. MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manholes for storm sewers.

B. Adjustment of existing manholes.

C. Connection to existing manholes.

D. Abandonment of manholes.

1.02 DESCRIPTION OF WORK

A. Construct storm sewer manholes, modify existing manholes, and abandon manholes where shown in the Plans.

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings showing compliance with this Specification.

C. Shop drawing schedule of new manholes showing total depth, relative elevations of all connecting sanitary or storm sewer lines, all drops, and orientation of connecting lines.

D. Catalog cuts of iron castings and sewer line connection gaskets.

E. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

C. Precast sections meeting the requirements of ASTM C 478.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:
1. Attend a preconstruction meeting if required by Engineer.
2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
2. Complete elements of the work which can affect line and grade in advance of other open cut construction unless noted on plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and Federal requirements.

C. Storm Sewer Manholes:
1. Manhole Types:

Type	Description	Main Pipe Size	Typical Depth	Figure No.
SW-401	48" Min. Dia. Short Cone or Flat Top with Poured or Precast Base	See Table 1 for Max. Dia. Pipe	7' Min.	6010.401
SW-402	Precast or Poured-in-Place Box with Precast or Poured-in-Place Base	24" or Greater	8' Max.	6010.402
SW-403	Poured-in-Place Box with Poured-in-Place Base	12" Dia. or Greater	6' - 12'	6010.403
SW-404	Combination 48" Dia. Short Cone with Poured-in-Place Barrel and Poured-in-Place Base	12" Dia. or Greater	12' - 22'	6010.404
SW-405	48" Dia. Short Cone with T-Section	42" Dia. or Greater eccentric reducer required for 42"	8.5' Min.	6010.405

2. Ring and Cover Types:

Type	Ring & Cover	No. of Pieces	Bolted Frame	Bolt Cover	Gasketed	Figure No.
E*	Standard	2	Yes	No	No	
F**	Adjustable	3	No	No	No	
G*	Machined Bearing Surfaces	2	No	No	No	

***** Use when placed in earth fill, asphalt pavement, or ACC manhole boxout.
** Use when placed in PCC pavement or PCC manhole boxout.

1.08 MEASUREMENT FOR PAYMENT

A. All measurements for payments will be made by the Engineer or authorized representative.

B. Manhole: For each type and size of manhole required and furnished, measure manhole vertical dimension in feet from the flow line to the top of the ring casting. Payment shall be at the unit bid price for each type and size of manhole properly installed. The unit bid price for manholes shall include all bedding, backfill, compaction and all appurtenances including castings and lids necessary for the proper installation.

PART 2 PRODUCTS

2.01 MANHOLES

A. Placement: Conform to elevations, locations and connection orientations shown on the Plans and detailed drawings.

B. Barrel Diameter, Inside: For sewers up to 24-inch size with two connections use 48 inches diameter barrel or as shown in the contract documents. For larger sewers or more connections, see Plans and detailed drawings.

C. Wall Thickness: See Detailed plans and Iowa SUDAS plans.

D. Top Configuration: Eccentric top except as noted on the Plans or detailed drawings. Total manhole depth 6 feet or more use cone top section. Total manhole depth less than 6 feet use minimum 9" thick flat top.

F. Joints, Barrel: Male and female ends with Mastic seal

G. Concrete: Precast: Comply with ASTM C 478. Cast in place: Refer to Cast-In-Place Storm Sewer Structure Section.

H. Base: Precast manhole: Separate base from riser section; use with precast base or poured base. Cast in place manhole: Use with precast base or poured base.

I. Pipe Connection:
   1. New Storm Sewer Manhole:
      a. Precast manholes: factory fabricated openings.
      b. Poured in place structures: structure wall poured around pipe stub.
   2. Existing Storm Sewer Manhole:
      a. Cored or drilled opening: Provide a flexible, watertight connection that meets and/or exceeds ASTM C 923.
      b. Knock out opening:
         1) Provide a watertight connection (waterstop or other method), meeting the material requirements of ASTM C 923, that is securely attached to the pipe with stainless steel bands or other means.
         2) Grout opening in manhole wall with non-shrink grout.
         3) Pour concrete collar around pipe and outside manhole opening.
         4) Provide flexible pipe joint or flexible connector within 2' of collar.

J. Manhole Steps: None, unless required on the Plans. If required, space steps at 12 to 16 inches, comply with ASTM C 478. Align with vertical side of eccentric cone top section.

2.02 MANHOLE ADJUSTMENT RINGS (Grade rings)

A. All grade adjustments of manhole frame and cover assemblies shall be completed utilizing one of the following:
   1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and be free from cracks, voids and other defects. Concrete rings will be set with asphalt mastic.
   2. High Density Polyethylene Grade Adjustment Rings: Comply with ASTM D 1248 for recycled plastic.
      a. Material properties shall be tested and certified for usage by the following ASTM methods:

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g / 10 min.
Density	ASTM D 792	0.94 to 0.98 g / cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 lb / in^2

b. Polyethylene adjusting rings shall not be used when they are exposed to heated hot mix asphalt pavement.
c. Tapered configuration: When used in a single configuration tapered adjusting ring thickness will range from 0.5 inch to 3.0 inch.
d. Grade adjustment rings are to be installed on clean flat surfaces according to the manufacturer's recommendations with the proper Butyl Rubber sealant/adhesives.

B. The inside diameter of the adjustment ring shall not be less than the inside diameter of the manhole frame.

C. Manholes shall be constructed with at least two adjustment rings.

D. Maximum height of adjustment ring stack: 12 inches max. for new manholes and 16 inches max. on existing manholes.

2.03 CASTINGS (Ring and Cover)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Storm Sewer Manhole Ring and Covers:
1. Grassed areas: Type E.
2. Paved areas, sidewalks, areas subject to vehicular traffic and sloped surfaces: Type F.
3. For installation directly into concrete pipe riser manhole, Type G.
4. Bolt all castings set above grade.
5. Storm sewer manhole lids shall not be bolted.

2.04 CEMENT MORTAR - Refer to Cast-In-Place Storm Sewer Structure Section.

2.05 REINFORCING STEEL - Refer to Cast-In-Place Storm Sewer Structure Section.

2.06 INVERT:

A. Poured in place concrete. Shape to provide a smooth transition between pipe inverts. Bring manhole invert up to one half of pipe diameter to produce a half pipe shape. Slope invert bench toward pipe 1/4 inch per foot perpendicular to flow line.

PART 3 - EXECUTION

3.01 MANHOLE INSTALLATION

A. Subgrade Preparation:
1. Undisturbed soil: Hand grade to accurate elevation.
2. Disturbed soil: Machine compact to 95 percent of Standard Proctor Density and hand grade to accurate elevation or install stabilization material as directed by Engineer.

B. Installation of Poured In Place Base: Bed base riser section in Class C concrete. Assure proper vertical and horizontal alignment of base riser section.

C. Installation of Precast Base with Base Riser: Assure proper vertical and horizontal alignment of base riser section.

D. Additional Risers: Install additional riser sections as required. Grout inside face of joints.

E. Repair: Repair any honeycomb areas or damaged areas as directed by Engineer.

F. Backfill up to pipe grades. Connect and bed pipes using bedding material up to one foot above top of pipes.

G. Install manhole invert. Remove any projections and repair any voids to assure a hydraulically smooth channel between pipe ends.

H. Install manhole top slab or cone.

I. Install manhole adjustment rings. Bed each ring with cold-applied bituminous jointing compound. Do not install more than total ring stack height of 12 inches. For greater adjustment, modify barrel riser section(s).

J. Install manhole ring and cover. Adjust accurately to proper grade. Where manhole is to be in a paved area, adjust slope to match finished surface.

K. Backfill and compact. Refer to Section 31 23 33. Use extra care to assure proper and uniform compaction of backfill around structure.

3.02 MANHOLE TESTING - Refer to Section 33 40 00.

B. INTAKES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Intakes for storm sewers.

B. Special structures for storm sewers.

1.02 DESCRIPTION OF WORK

A. Construct intakes and special structures for storm sewers.

B. Modify existing intakes

C. Abandon intakes.

D. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings showing compliance with this Specification.

C. Schedule of new intakes showing total depth, and relative elevations and orientations of all connecting storm sewer lines.

D. Catalog cuts of iron castings.

E. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:
   1. Attend a preconstruction meeting if required by Engineer.
   2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
   1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
   2. Complete elements of the work which can affect line and grade in advance of other open cut construction unless noted on plans.
   3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and Federal requirements.

1.08 MEASUREMENT FOR PAYMENT

A. All measurements for payments will be made by the Engineer or authorized representative.

B. Intake: Measure the number of all properly completed intakes. Payment shall be at the unit bid price for each size and type, and shall include all bedding, backfill, compaction, grates and appurtenances for proper installation.

C. Intake Adjustment: Count each item as a completed individual unit, as identified in the Bid Schedule. Payment shall be at the unit bid price for each adjustment as per plan.

D. Special Structure: Count each item as a completed individual unit, as identified in the Bid Schedule.

PART 2 - PRODUCTS

2.01 INTAKES

A. Conform to elevations, locations and connection orientations shown on the Plans.

B. Intake type; Refer to Plans.

C. Configuration and Dimensions; Refer to Detailed Drawings.

D. Top Configuration:
1. As noted on Detailed Drawings.
2. Number of grate sections; Refer to Plans.

E. Joints, Wall:
1. Precast; Male and female ends, mastic seal.
2. Poured in place; construction joints.

F. Concrete:
1. Precast: Precast concrete intakes constructed in accordance with the requirements of following Cast In Place Section, and with the dimensions and reinforcement shown in standard detailed drawings.
2. Cast in place;
   a. Refer to following Cast-In-Place Section.
   b. Minimum concrete reinforcing cover 2 inches.
   c. Minimum total section thickness; see Standard Detailed Drawings.

G. Base:
1. Separate. Use with base riser section with square bottom edge.
2. Precast may have surface finish block outs on one side only.

H. Pipe Connection:
1. Precast intake; factory fabricated openings.
2. Poured in place structures; structure wall poured around pipe stub.

I. Manhole Steps: None, unless required on the Plans. If required, space steps at 12 to 16 inches, comply with ASTM C 478.

2.02 INTAKE ADJUSTMENT RINGS (Grade rings)

A. All grade adjustments of intake frame and cover assemblies shall be completed utilizing one of the following:
1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and be free from cracks, voids and other defects. Concrete rings will be set with asphalt mastic.
2. High Density Polyethylene Grade Adjustment Rings: Comply with ASTM D 1248 for recycled plastic.
   a. Material properties shall be tested and certified for usage by the following ASTM methods:

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g/10 min.
Density	ASTM D 792	0.94 to 0.98 g/cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 lb/in^2

b. Polyethylene adjusting rings shall not be used when they are exposed to heated hot mix asphalt pavement.
c. Tapered configuration: When used in a single configuration tapered adjusting ring thickness will range from 0.5 inch to 3.0 inch.
d. Grade adjustment rings are to be installed on clean flat surfaces according to the manufacturer's recommendations with the proper Butyl Rubber sealant/adhesives.

B. The inside dimension of the adjustment ring shall not be less than the inside dimension of the intake grate opening.

C. Intakes shall be constructed with at least two adjustment rings.

D. Maximum height of adjustment ring stack: 12 inches for new and existing intakes.

2.03 CASTINGS (Covers and Grates)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Type: Refer to Detailed Drawings and Plans.

2.04 CEMENT MORTAR - Refer to following Cast In Place Section.

2.05 REINFORCING STEEL - Refer to following Cast In Place Section.

2.06 INVERT

A. Poured in place concrete. Establish a full seal between base and base riser section.

B. Shape to provide a smooth transition between pipe inverts.

C. Bring intake invert up to one half of pipe diameter to produce a half pipe shape.

PART 3 EXECUTION

3.01 INTAKE INSTALLATION

A. Subgrade Preparation:
1. Undisturbed soil: Hand grade to accurate elevation.
2. Disturbed soil: Machine compact to 95 percent of Standard Proctor Density and hand grade to accurate elevation, or install Stabilization Material as directed by Engineer.
3. Unstable soil: Install Stabilization Material as directed by Engineer.

B. Concrete Intakes:
1. Install Stabilization Material if unstable base exists.
2. Install Granular Bedding Material if required by Detailed Drawings.
3. Install base; assure proper vertical and horizontal alignment of base riser section.
4. Install additional riser section as required. Seal all joints.
5. Repair any honeycomb areas or damaged areas.
6. Compact backfill up to connecting pipes.
7. Connect and bed pipes per Section 3010. Grout inside pipe/riser joint.
8. Install intake invert. Remove any projections and repair any voids to assure a hydraulically smooth channel through intake.
9. Install top.
10. Install adjustment rings. Install at least two rings. Bed each ring with cold-applied bituminous jointing compound. Do not install more than total ring stack height of 12 inches. For greater adjustment, modify riser section(s).
11. Install top casting. Adjust accurately to proper line and grade.

12. Backfill and compact. Refer to Section 3010. Use extra care to assure proper and uniform compaction of backfill around structure.

C. Anchoring Castings: All castings not encased in concrete shall be bolted down.

3.02 CONCRETE, REINFORCEMENT, AND PLACEMENT. Refer to Cast In Place Section.

3.03 SPECIAL STRUCTURES

A. Construct in accordance with this Section, as applicable.

B. Refer to Plans for locations, dimensions and special details and provisions.

3.04 ABANDONED INTAKES

A. Remove entire structure to a minimum of 10 feet below subgrade in paved areas or 6 feet below finish grade in other areas.

B. Plug all pipes in structure.

C. Fill remaining structure using flowable mortar.

D. Place compacted earth fill over structure as required for embankment or compacted backfill.

C. CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural Portland cement concrete and reinforcing for manholes and intakes for sanitary and storm sewer systems, and other structures such as concrete thrust blocks and sewage air release pits as designated by the Engineer.

1.02 DESCRIPTION OF WORK

A. Construct Portland cement concrete structures for sanitary and storm sewers.

B. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings of steel reinforcement, showing sizes, lengths, bends, and counts, if required.

C. Concrete mix design, if required by Engineer.

D. Sample test results and certifications.

E. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.

F. Project Record Documents.

G. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications and for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Store reinforcing steel only on pallets or lagging. Replace any damaged materials. Remove damaged materials from the site.

C. Aggregate storage and concrete transport shall follow Section 7010, 1.05.

1.06 SCHEDULING

A. Construction Sequence:
   1. Schedule concrete placement to coordinate with other work, such that trenching, backfilling and other work can proceed in an orderly manner and to provide the greatest protection for new work.

B. Conflict Avoidance:
   1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations and verify clearance for proposed construction.
   2. Complete elements of work which can affect line and grade in advance of pipe construction unless noted on plans.
   3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and federal requirements.

C. Restrictions: Restriction on operations shall follow Section 7010, 1.07.

1.08 MEASUREMENT FOR PAYMENT

A. The cost for concrete and reinforcing in the construction of manholes and intakes for storm sewer systems, or other special structures, will not be measured separately but will be considered incidental to intakes and manholes or other concrete structures as described in this specification document, including sampling and testing.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Portland Cement:
   1. ASTM C 150, Type I or Type III when specified.
   2. Air entrained per ASTM C 260.

3. Iowa DOT Class C concrete unless otherwise specified in the contract documents.

B. Aggregates:
   1. Per ASTM C 33.
   2. Coarse and fine aggregate shall follow Section 7010, 2.02.

C. Water: Follow Section 7010 2.02 E

D. Liquid Admixtures for Portland Cement Concrete:
   1. Description
      a. Meet requirements of AASHTO M 154 for air entraining mixtures.
      b. Meet requirements of AASHTO M 194 for other liquid admixtures.
      c. Submit tests by a recognized laboratory for Engineer approval.
      d. Admixtures containing more than 1% chloride ions shall not be allowed unless approved by Engineer.
      e. Inspection and acceptance of liquid admixtures will be in accordance with Iowa DOT Materials I.M. 403
   2. Air Entraining Admixtures: Provisions shall be made to stir, agitate, or circulate air entraining admixtures prior to use to insure a uniform and homogeneous mixture.
   3. Retarding and Water Reducing Admixtures
      a. Shall be compatible with air entraining agent.
      b. Shall be introduced into the mixer after all other ingredients
      c. Agitate prior to and during use in accordance with Iowa DOT Materials I.M. 403
      d. Dosage rate shall be applied to both cement and fly ash when used.
   4. Other Admixtures: Other admixtures may be used with the approval of the Engineer in accordance with the manufacturer's recommendations.

2.02 CONCRETE QUALITY

A. Compressive Strength: Minimum 4,000 psi at 28 days.

B. Water-Cement Ratio: Follow Section 7010, 2.03.

C. Air Content: The intended air entrainment is 6.0%. To allow for loss during placement, the air content of fresh, unvibrated structural concrete shall be 6.5%, as a target value, with a maximum variation of plus or minus 1.0%.

D. Slump: Structural concrete shall be placed with a slump between 1 inch and 3 inches as a target range, allowing a maximum of 4 inches unless specifically modified by the Engineer.

E. Admixtures: Per manufacturer’s recommendations.

2.03 REINFORCEMENT

A. Reinforcing Steel:
   1. Use deformed bars.
   2. Epoxy coated deformed bars apply only when specified.
   3. Billet steel; ASTM A 615, Grade 60.
   4. Fabricate and bend, per approved submittals or Plans.
   5. Fabricate all bars prior to delivery to site unless field bends are required.

B. Wire Fabric:
   1. Per ASTM A 185.
   2. Size and mesh; as shown on Detailed Drawings or on Plans.
   3. Placement; as shown on Detailed Drawings or on Plans.
   4. Joints; lap not less than 6 inches.

2.04 CEMENT MORTAR: Mix in the following portions:

A. Portland Cement: Type I; 10 Parts

B. Mortar Sand: 20 Parts

C. Lime, Hydrated: 3/4 to 1 Part

PART 3 EXECUTION

3.01 FORMING

A. All cast in place manholes and structures shall be formed on both the inside and the outside face above the base. No earth excavation next to the proposed manhole shall be used as forming.

B. Use metal or plywood-lined forms for exposed surfaces.

C. Erect and secure forms to true line and grade.

D. Coat forms with non-staining mineral oil before placing reinforcing. Do not apply oil to surfaces to which concrete must be bonded.

E. Use 3/4 inch bevel for exposed corners, unless otherwise required.

3.02 REINFORCING STEEL

A. Remove dirt, scale and other materials that might impair concrete bond.

B. Place reinforcement where shown. Space bars properly and secure in position.

C. Reinforcement for slabs; support with chairs or bolsters. Do not use wood, bricks, stones or other foreign materials.

D. Lap bars 36 diameters, except as otherwise shown.

3.03 MIXING: (IOWA DOT 2403)

A. Provide accurate control for measuring materials.

B. Concrete, as discharged from the mixer, shall be uniform in composition and consistency. Each batch of concrete shall be thoroughly discharged from the mixer before the next batch is introduced. Upon cessation of mixing for any considerable length of tie, the mixer shall be thoroughly cleaned and flushed with water.

C. Ready-Mixed Concrete: conform to ASTM C 94.

3.04 PLACING

A. Clean and dampen forms, reinforcing steel and embedded items.

B. Prevent segregation during placement. Do not allow concrete to fall more than 4 feet from placement chute to final position.

C. Place concrete continuously in each section until complete. Do not allow more than 30 minutes between depositing adjacent layers of concrete within each section.

D. Thoroughly compact, puddle and vibrate concrete into corners and around reinforcing and

embedded items. Vibrate sufficiently to work concrete into crevices and around steel. Refer to Iowa DOT 2403.09.

E. Place sections of concrete in a sequence which eliminates the effect of shrinkage to the greatest extent practicable.

F. Concrete shall not be placed when the air temperature is less than 40 degrees Fahrenheit without the approval of the Engineer. Refer to Iowa DOT 2403.11.

3.05 FINISHING

A. Refer to Iowa DOT 2403.21.

B. Use rough form finish to areas not visible to the public.

C. Use smooth form finish for areas visible to the public.

D. Use broomed finish for slabs, except as noted on Plans or Detailed Drawings.

3.06 STRIPPING AND CLEANING

A. Remove forms for manhole and intake walls and tops according to Iowa DOT 2403.18.
1. References to culverts shall include all sanitary and storm structures.
2. When allowed by the Engineer, compressive strengths at six times the stated flexural strengths may be used in determining concrete strength of structure roofs.

B. Chip out and repair any honeycomb areas per direction of Engineer.

C. Break back form ties and fill holes with portland cement mortar.

D. Remove flashing and thin webs.

3.07 CURING

A. Refer to Iowa DOT 2403.10.

B. Apply curing system immediately after finishing or stripping of forms, as applicable.

C. Slabs on grade, visible to the public; use only curing compounds meeting ASTM C 309, Type 1-D or Type 2.

3.08 EXTERIOR LOADING

A. Restrict loads on concrete, other than the load caused by the weight of the concrete itself, according to Iowa DOT Section 2403.19.

B. When allowed by the Engineer, compressive strengths at six times the stated flexural strengths may be used.

3.09 TESTING

A. Provide required testing by a testing service approved by Engineer, unless such services are provided by Jurisdiction.

B. Review and test proposed mix design when required by Engineer.

C. Obtain production samples of job-delivered concrete mix after any needed water has been added

and the concrete remixed.

D. Mold and cure three specimens per ASTM C 31.

E. Strength Testing: Unless otherwise specified in the contract documents strength testing will be the responsibility of the Contractor by a certified testing service.
   1. Test specimens in accordance with ASTM C 39. Test one sample at 7 days for information. Test two samples at 28 days. The acceptance test results shall be the average of the compressive strength of the two specimens tested at 28 days. If one of the 28 day samples manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining sample shall be considered the test result.
   2. Make at least one strength test for each 100 cubic yards or fraction thereof, and at least one test for each structure. When the total quantity is less than 50 cubic yards the strength tests may be waived by the Engineer.

F. Slump Testing: Unless otherwise specified in the contract documents testing will be by the Engineer. Determine slump of concrete sample for each strength test and whenever consistency of concrete mix appears to vary, using ASTM C 143.

G. Air Testing: Unless otherwise specified in the contract documents testing will be by the Engineer. Determine air content of concrete sample for each strength test in accordance with either ASTM C 231, ASTM C 173, or ASTM C 138.

D. NYLOPLAST INTAKES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nyloplast Intake substitutes for certain types of concrete Intakes and vice versa.

1.02 DESCRIPTION OF WORK

A. Nyloplast Structures are allowed to be substituted for Iowa SUDAS SW-501 and SW-512 Intakes. Nyloplast intake substitutions for SW-512 area intakes must be the same size vertical barrel and grate that is called out on plans.

B. No other concrete structures are allowed to have substitutions including other types of intakes and all manholes.

C. Nyloplast Basins can be substituted with SUDAS Pre-Cast Manholes/ Intakes. SW-512 intakes are NOT an approved substitution for Nyloplast structures.

1.03 SUBMITTALS

A. Shop drawings of Nyloplast structure prior to fabrication.

B. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.

C. Project Record Documents.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications and for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

C. Aggregate storage shall follow Section 7010, 1.05.

1.06 SCHEDULING

A. Construction Sequence:
1. Schedule intake placement to coordinate with other work, such that trenching, backfilling and other work can proceed in an orderly manner and to provide the greatest protection for new work.

B. Conflict Avoidance:
1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations and verify clearance for proposed construction.
2. Complete elements of work which can affect line and grade in advance of pipe construction unless noted on plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and federal requirements.

C. Restrictions: Restriction on operations shall follow Section 7010, 1.07.

1.08 MEASUREMENT FOR PAYMENT

A. The cost for granular backfill and intake castings for storm sewer systems, or other special structures, will not be measured separately but will be considered incidental to intakes and manholes.

PART 2 PRODUCTS

2.01 MATERIALS

A. Intake:
1. PVC Stock Pipe, utilizing a thermo-molding process to reform the pipe stock to the specified configuration.
2. Drainage pipe connection stubs stall be PVC pipe stock and formed to provide watertight connection with the specified pipe system sizes and angles.
3. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs shall conform to ASTM D1784 cell class 12454.

B. Joints:
1. Joint tightness shall conform to ASTM D3212 for drain and sewer plastic pip using flexible elastomeric seals.
2. Flexible elastomeric seals shall conform to ASTM F477.
3. The pipe bell spigot sall be joined to the main body of the drain basin or catch basin.

C. SW-512 and A2000 Area Intake Grates for Nyloplast structures:
1. Grates and frames furnished for all Nyloplast intake structures shall be ductile iron and the same size as the intake stack.
2. Intake grates shall be capable of handling H-20 loads for all structures placed into paving.
All other structures shall comply with H-10 loading.
3. Metal used in manufacture of the castings shall conform to ASTM A536 grade 70-50-05 ductile iron.
4. Grates shall be natural and contain no paint.

D. SW-501 Intake Grates for Nyloplast structures:
1. The grate, frame and hood assembly shall be ductile iron.
2. The grate, frame and hood shall all be capable of supporting H-20 loading.
3. The hood section will have a solid back and be adjustable by use of three (3) hex head bolts.
4. Metal used in manufacture of the castings shall conform to ASTM A536 grade 70-50-05 ductile iron.
5. Grates shall be natural and contain no paint.

PART 3 EXECUTION

3.01 INSTALLATION

A. All intakes shall be staked by a licensed land surveyor.

B. Intakes shall be placed in accordance with stakes provided by surveyor. In the event of a discrepancy between stakes and plans, contractor shall contact engineer and/ or land surveyor prior to intake placement.

C. Granular backfill for base and intakes shall comply with manufacture recommendations. All backfill material shall conform with IOWA SUDAS backfill specifications for concrete intakes. Sand in NOT a permitted backfill material and backfill shall be Class 2 material defined in ASTM D2321.

D. Intakes shall be designed and placed approximately 12” over height. Upon completion of final grading, Intakes shall be cut to the grade as specified on the approved construction plans. If intake stack is either manufactured too short or cut too short in the field, intake shall be completely replaced at contractor/ manufacture’s expense.

E. All intakes installed in paved areas (H-20 loaded structures), a concrete ring shall be poured under and around the grate and frame. The concrete slab must be designed for local soil conditions, traffic loading, among any other applicable design factors.

F. For any other installation considerations such as migration of fines, ground water and soft foundations, refer to ASTM D2321 guidelines.

END OF SECTION

SECTION 21 0500
BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 21 Sections. Also refer to Division 01 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the bid documents and/or Construction Manager's scope statements for complete scope of work description.

D. Scope of Work:

1. Plumbing Work: Refer to Section 22 0500 "Basic Plumbing Requirements".
2. Heating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
3. Air Conditioning and Ventilating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
4. Temperature Control Work: Refer to Section 23 0500 "Basic HVAC Requirements".
5. Fire Protection Work shall include, but is not necessarily limited to:
    a. Extend existing wet pipe sprinkler system for areas noted on the drawings.
    b. Furnish and install all items listed on the Fire Protection Material List.
    c. Furnish all hydraulic calculations and working sprinkler drawings.
    d. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work. Refer to 07 8400.
    e. Complete all applicable tests, certifications, forms, and matrices.
6. Testing, Adjusting, and Balancing Work: Refer to Section 23 0500 "Basic HVAC Requirements".

1.03 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. The Owner reserves the right to determine when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 ALTERNATES

A. Bakery Equipment: Rough-ins are part of Base Bid.

B. Laundry Equipment: Rough-ins are part of Base Bid where noted on the drawings.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
    a. Plumbing Contractor.
    b. Heating Contractor.
    c. Air Conditioning and Ventilating Contractor.
    d. Temperature Control Contractor.

e. Fire Protection Contractor.

f. Testing, Adjusting, and Balancing Contractor.

2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.

3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.

4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.

5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.

   a. This wiring will be from a 120 volt source and may continue as 120 volt or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.

6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.

3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.

4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
    a. Light fixtures.
    b. Gravity flow piping.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:
1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
    a. Burners.
    b. Condensing Units.
    c. Gas Trains.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.

6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    a. Scale of drawings:
        1) General plans: 1/4 Inch = 1 '-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa’s Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:
   1. Secure from the appropriate private or public utility company all applicable requirements.
   2. Comply with all utility company requirements.
   3. Make application for and pay for fire protection water service connection.

F. Examination of Drawings:
   1. The drawings for the fire protection work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
   2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
   3. Scaling of the drawings is not sufficient or accurate for determining these locations.
   4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
   5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
   6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
   7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
   8. Where used in fire protection documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
      a. Any item listed as furnished shall also be installed, unless otherwise noted.
      b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:
   1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:
   1. Construction drawings for this project have been prepared utilizing Revit.
   2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
   3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
   4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
   5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
   6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
   7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
   8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
21 05 00	Owner Training Agenda
21 05 29	Hangers and Supports
21 13 00	Sprinkler Systems
21 13 00	Fire Protection Equipment

B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Division of work (e.g., plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor's review stamps
3. Composition:
   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
    a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
    b. Unstamped submittals will be rejected.
    c. The Contractor's review shall include, but not be limited to, verification of the following:
        1) Only approved manufacturers are used.
        2) Addenda items have been incorporated.
        3) Catalog numbers and options match those specified.
        4) Performance data matches that specified.
        5) Electrical characteristics and loads match those specified.
        6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
        7) Dimensions and service clearances are suitable for the intended location.
        8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
        9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
    d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
    e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
    a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
    b. The Contractor shall clearly indicate the size, finish, material, etc.
    c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
    d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions. or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 21 XX XX.description.YYYYMMDD
    b. Transmittal file name: 21 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Coordinate the installation of heavy and large equipment with all contractors and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

C. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.13 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.14 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection

with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Covering exterior walls, interior partitions and chases.
2. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
   a. Pipe wall penetrations are sealed.
   b. Pipe identification is installed.
   c. Branch piping in the location of sprinklers shall be dropped to the ceiling.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.03 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Inspection report by the State Fire Marshal of the fire protection system.
5. Start-up reports on all equipment requiring a factory installation inspection or start-up.

6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.04 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div21.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div21.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, one paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.05 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.
5. Description of emergency system operation.

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

F. Minimum hours of instruction for each item shall be:

1. Sprinkler System(s) - 2 hours.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts,

etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the fire protection and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.06 SYSTEM STARTING AND ADJUSTING

A. The fire protection systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.07 RECORD DOCUMENTS

A. The following paragraphs supplement Division 01 requirements.

B. Maintain at the job site a separate and complete set of fire protection drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations of other control devices, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

D. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

E. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

F. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.08 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

B. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

3.09 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Refer to Division 00 and Division 01 specifications for additional requirements which may include special requirements for work within the correctional facility.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. Fire protection system operational.
3. Pipes labeled.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 21 0505
FIRE SUPPRESSION DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fire Suppression Demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.02 PREPARATION

A. Disconnect fire protection systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

3.03 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Remove, relocate, and extend existing installations to accommodate new construction.

B. Remove abandoned piping to source of supply and/or main lines.

C. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

D. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

E. Repair adjacent construction and finishes damaged during demolition and extension work.

F. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.04 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 21 0529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. FIRE PROTECTION ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.06 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 21 0529
FIRE SUPPRESSION SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.02 QUALITY ASSURANCE

A. Support Sprinkler Piping in conformance with NFPA 13.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 21 0500.

1.04 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to Division 3 Contractor for placement into formwork.

PART 2 - PRODUCTS

2.01 HANGER RODS

A. Hanger rods for single rod hangers supporting steel piping shall conform to the following:

Pipe Size	Rod Size
4" and smaller	3/8"
5" 6", and 8"	1/2"

B. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.02 PIPE HANGERS AND SUPPORTS

A. General:

1. All pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS-SP-58, -69, -89, and -127 (where applicable).

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, and more frequently when required by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings or lugs. Provide sufficient flexibility to accommodate expansion and contraction without compromising fire barrier penetrations and other fixed takeoff locations.
   a. Products:
      1) Anvil Fig.
      2) CT121
      3) Cooper/B-Line Fig.
      4) B3373CT
      5) Erico Model 510
      6) Nibco/Tolco Fib. 82

2. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs.
3. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:
1. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
2. Unless otherwise indicated, hangers shall be as follows:
   a. Clevis Type: Service: Bare Metal Pipe
      1) Products: Bare Steel
         a) Anvil Fig. 260
         b) Cooper/B-Line Fig. 3100
         c) Erico Model 400
         d) Nibco/Tolco Fig. 1.
   b. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller
      1) Products: Bare Steel Pipe
         a) Anvil Fig. 69
         b) Cooper/B-Line Fig. B3170NF
         c) Erico Model FCN
         d) Nibco/Tolco Fig. 200.
3. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
4. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
5. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
6. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
   a. Clamp Type: Service: Bare Metal Pipe
      1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
      2) Pipes subject to expansion and contraction shall have clamps slightly oversized to allow limited pipe movement.
      3) Products: Bare Steel
         a) Unistrut Fig. P1100 or P2500
         b) Cooper/B-Line Fig. B2000 or B2400
         c) Nibco/Tolco Fig. A-14 or 2STR.

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.)

1) Products:

a) Anvil Fig. 92

b) Cooper/B-Line Fig. B3033/B3034

c) Erico Model 300

d) Nibco/Tolco 68.

b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

1) Products:

a) Anvil Fig. 228, 292

b) Cooper/B-Line Fig. B3054

c) Erico Model 360

d) Nibco/Tolco Fig. 329.

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

1) Products:

a) MCL. M1, M2 or M3

d. Concrete Inserts Single Rod Galvanized:

1) Products:

a) Anvil Fig. 282

b) Cooper/B-Line Fig. B3014

c) Erico Model 355

d) Nibco/Tolco Fig. 310

e. Concrete Inserts Continuous Strip Galvanized:

1) Products:

a) Unistrut Corp P3200 Series

b) Cooper/B-Line Fig. B22-J

c) Erico CONCT

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

g. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

h. Steel Structure Welding:

1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and for protecting walls and ceilings from being damaged by smoke.

2.03 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the Division 3 Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.04 PIPE SLEEVES AND LINTELS

A. Each Contractor shall provide pipe sleeves and lintels for all openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Engineer's design.

F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

G. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.05 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes duct and pipe openings.

2.06 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.07 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.08 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.01 FIRE SUPPRESSION SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    a. The hanger is attached within 6" from a web/chord joint.
    b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.

3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall in no case exceed the following:
1. Steel (All steel pipe unless otherwise noted):
a. Maximum Spacing:
1) 1-1/4" & under: 12'-0"
2) 1-1/2" & larger: 15'-0"

I. Installation of hangers shall conform to MSS SP-58, -69, -89, and applicable NFPA standards.

END OF SECTION

SECTION 21 1300
FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe, Fittings, Valves, and Connections for Fire Protection System.

B. Wet-Pipe Sprinkler System.

1.02 QUALITY ASSURANCE

A. Welding Materials and Procedures: Conform to ASME Code.

B. Equipment and Components: Bear UL label or marking.

C. Valves: Bear UL label or marking. Provide manufacturer's name and pressure rating marked on valve body. Pressure rating shall match specified pipe system pressure rating. Remanufactured valves are not acceptable.

D. Sprinkler design drawings submitted by the Contractor shall be prepared by a NICET Water-Based Fire Protection Systems Layout Level III or Level IV designer or PE.

1.03 SUBMITTALS

A. Submit shop drawings per Section 21 0500. Indicate pipe materials, joining methods, supports, floor and wall penetration seals, sprinklers, equipment data and ratings, and hydraulic calculations.

B. Submit detailed pipe and sprinkler layout and other calculations and forms as described in NFPA 13.

C. Submit detailed working drawings and obtain review of them in the following order:

1. Engineer/Architect
2. State Fire Marshal/Authority Having Jurisdiction
3. Architect/Engineer

D. Working drawings shall include piping and sprinkler layout, sprinkler types and ratings, sections and elevations at critical points. Show coordination with lighting, ductwork, and diffusers, and indicate basic flow and hydraulic design information, including main location and date that the test was taken.

E. Provide the Owner with one copy of NFPA 25. Standard for the Inspection Testing and Maintenance of Water-based Fire Protection Systems.

1.04 EXTRA STOCK

A. Provide metal storage cabinet, wrenches for each sprinkler type, and extra sprinklers per NFPA 13 and applicable building code.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store valves and sprinklers in shipping containers, with labels in place.

B. Provide temporary protective coating on iron and steel valves.

C. Maintain temporary end caps and closures in place until installation.

1.06 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves to Division 3 Contractor for placement in walls and floors. Sleeve location to be determined by the Fire Protection Contractor prior to construction. If additional sleeves are required, they shall be core drilled by the Fire Protection Contractor.

1.07 SYSTEM DESCRIPTION

A. Contractor shall design and install the following water-based fire protection systems for the areas noted on the contract documents:

1. Wet pipe sprinkler system(s)

B. Sprinkler systems shall be designed and installed according to the following standard(s):

1. NFPA 13 - Standard for the Installation of Sprinkler Systems

C. System design and installation shall include all requirements by the Authority Having Jurisdiction, local and state building codes in addition to the previously listed design standard(s). Those requirements shall take precedence over the contract documents in the case of discrepancies.

D. Systems shall be hydraulically calculated in accordance with the applicable design standard(s). Contractor is responsible for final pipe sizing based on results from hydraulic calculations. Pipe sizing shown on drawings for service entrance and main risers is preliminary and for coordination purposes only.

E. The water supply source for this project is the following:

1. Private waterworks system with fire pump.
2. Contractor shall determine the flow and pressure available. For reference, there were several hydraulic system tags on wall near fire pump. They indicated around 60 psi at base of the riser with flow rates around 300 gpm.
3. System design shall provide a safety factor when comparing available water supply pressure versus system design pressure at design flow rate (including hose streams). The safety factor shall be the following:
    a. 5 psig

1.08 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 21 0500 for required fire protection systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit manufacturers' operation and maintenance data. Include written maintenance data on components of system, servicing requirements, and record drawings.

1.10 JOB CONDITIONS

A. Fire Protection Contractor shall determine the flow and pressure available at the service connection. The Fire Protection Contractor is responsible to verify this information and make all tests required. Base all pipe sizing and hydraulic calculations on flow test data no older than 18 months.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS - WET PIPE SPRINKLER SYSTEMS

A. Piping - 2" and Under (Steel Pipe):

1. Design Pressure: 175 psig
2. Pipe: Schedule 40, black steel, ASTM A53, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3.
4. Fittings:
    a. Threaded:
        1) Cast iron, Class 125, black, UL, ANSI/ASME B16.4.
        2) Malleable iron, Class 150, black, UL, ANSI/ASME B16.3.
        3) Ductile iron, Class 150, black, UL, ANSI/ASME B16.3.
    b. Grooved:
        1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL, enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
    c. Flanged:
        1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1.

5. Unions: Class 150 malleable iron, ANSI B16.39, ground joint with copper or copper alloy-to-iron seat.

B. Piping - 2-1/2" and Above (Steel Pipe):

1. Design Pressure: 175 psig
2. Pipe: Schedule 10, black steel, ASTM A135, ASTM A795, UL. Inner wall shall be coated with an anti-MIC (microbiologically influenced corrosion) coating.
3. Fittings:
   a. Grooved:
      1) Ductile iron housing ASTM A-536, Grade 65-45-12, UL enamel coating, Grade E (Type A) EPDM molded pressure-responsive gaskets suited for 40°F to 150°F. Carbon steel bolts and nuts.
   b. Flanged:
      1) Cast iron, Class 125, black, UL, ANSI/ASME B16.1.

2.02 FLEXIBLE FIRE SPRINKLER CONNECTIONS

A. Flexible Connection: Stainless steel hose, 175 psig max working pressure, fully welded non-mechanical fittings, stainless steel braid, maximum of 6' hose length, leak-tested with a minimum 7/8" internal corrugated hose diameter made of 304 stainless steel, end fittings made of carbon or stainless steel. Outlet of end fittings shall be 1/2" or 3/4" to match sprinkler connection. UL.

B. Ceiling Bracket: G90 galvanized steel, direct attachment type, integrated snap-on clip ends, tamper resistance screws, removable attachment hub with set screw for attachment and adjustment of stainless steel hose.

1. Manufacturers:
   a. Flexhead Industries
   b. Victaulic VicFlex,
   c. Sprinkflex
   d. or approved equal.

2.03 VALVES

A. Provide handwheels for gate valves. Provide gear operators for butterfly valves.

B. Provide all connections to match pipe joints. Valves shall be same size as pipe.

2.04 EQUIPMENT

A. Equipment shall be as scheduled on the drawings.

2.05 RISER LABELING AND IDENTIFICATION

A. Hydraulic nameplates shall be affixed to each riser and shall include the following minimum information:

1. Installation contractor
2. Date installed
3. Riser location
4. Number of sprinklers
5. Basis of design (density GPM/ft2 and area of coverage ft2
6. Water flow rate (GPM) and residual pressure (psi) at the base of riser
7. Hose stream allowance (GPM).
8. Occupancy classification
9. Commodity classification (If applicable)
10. Maximum storage height (if applicable)

2.06 PIPE LABELING AND IDENTIFICATION

A. All pipe shall be marked along its length by the manufacturer in such a way as to properly identify the type of pipe. The manufacturer pipe marking shall be visible on every piece of pipe over 2 ft (600 mm) long. Manufacturer pipe identification shall include the manufacturer's name, model designation, and/or schedule.

PART 3 - EXECUTION

3.01 INSTALLATION - PIPING

A. General Installation Requirements:

1. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over sprinkler piping and sprinklers.
2. Ream pipe and tube ends to full inside diameter. Remove burrs. Remove scale and foreign material, inside and outside, before assembly.
3. Die cut screw joints with full cut standard taper pipe threads.
4. Coat threads with pipe joint compound or wrap with Teflon tape.
5. Locate piping to minimize obstruction of other work.
6. Route piping in concealed spaces above finished ceiling.
7. Use full and double lengths of pipe wherever possible.
8. Slope all piping for complete drainage. Install auxiliary drains for all trapped piping per NFPA 13.
9. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
10. Comply with manufacturer's installation instructions.

B. Steel Piping:

1. In steel piping, main sized saddle branch connections or direct connection of branches to main is permitted if main is one pipe size larger than the branch for up to 6" mains and if main is two pipe sizes larger than branch for 8" and larger mains. Do not project branch pipes into main pipes.

C. Wall/Floor Penetration:

1. Provide sleeves when penetrating floors and walls.
2. Seal pipes passing through exterior walls with a wall seal per Section 21 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe. Sleeves through floors shall extend minimum 1.5" above finished floor.
3. Fire seal all pipe and sleeve penetrations (both wall and floor) to maintain fire separation required without restraining pipe.

D. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment. Fire protection equipment dedicated to the electrical equipment room or space may be installed above equipment if other alternatives are not available.

E. Hangers and Supports:

1. Provide hangers and supports as required by NFPA 13 and UL, with the following exceptions:
   a. Do not use powder driven devices, explosive devices, wooden plugs, or plastic inserts.
   b. Do not install fasteners to carry the load in tension, unless absolutely necessary.

F. Exposed Piping:

1. Install chrome plated steel escutcheons where exposed pipes penetrate walls or floors.
2. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories.

3.02 INSTALLATION - VALVES

A. Install gate valves with stems upright or horizontal, not inverted.

B. Shutoff Valve:

1. Provide drain valves at main shutoff valves, low points of piping and apparatus.
2. Provide monitor switches on all shutoff valves.

3.03 INSTALLATION - EQUIPMENT

A. Coordinate piping and sprinkler locations with all other trades. Ductwork, diffusers and light fixture locations shall have priority over system equipment and sprinklers.

B. Test Valves:

1. Install test valves where required. Pipe to outdoors or drain. Test connection shall have flow equivalent to the smallest K-factor sprinkler.

C. Sprinklers:

1. Locate sprinklers to clear lights, ducts and diffusers. Do not run sprinkler pipes through ducts. Ductwork has priority over sprinkler pipes. Offset pipes as needed.
2. Center sprinklers in two directions in ceiling tiles and provide offsets as required.
3. Do not allow concealed sprinkler cover plates to be painted. Sprinkler cover plates are to be factory painted only. Do not field paint.
4. Apply strippable or paper covers so concealed sprinkler cover plates do not receive field paint finish.

3.04 SYSTEMS CLEANING AND TESTING

A. General Requirement:

1. All water used for testing and remaining in the piping system shall be obtained from a potable water source.

B. Interior Piping:

1. Verify adequate water flow at the inspector's test connection.
2. Flush all interior piping to remove scale and other foreign material before placing system into service.
3. Hydrostatically test the entire interior piping system at a minimum of 200 psig or 50 psig more than the normal system working pressure for systems subjected to pressures more than 150 psig. Maintain test pressure for 2 hours without loss of pressure.

C. Fire Alarm System:

1. Test the alarm system by operating the inspector's test connection or the alarm test valves. Verify that the building fire alarm system activates.
2. Adjust all monitor switches for proper operation.

END OF SECTION

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SECTION 22 0500
BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the bid documents and/or Construction Manager's scope statements for complete scope of work description.

D. Scope of Work:

1. Plumbing Work shall include, but is not necessarily limited to:
    a. Furnish and install all items listed in the Plumbing Material List.
    b. Extend existing domestic water piping system including cold, hot, and hot water circulating piping within the building. Insulate all piping as specified.
    c. Extend existing gas piping system including all meter requirements.
    d. Furnish and install water softener.
    e. Furnish and install water heaters.
    f. Furnish and install condensate drain piping from plumbing related equipment such as ice machines.
    g. Furnish and install complete sanitary sewer and vent system.
    h. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work. Refer to 07 8400.
    i. Complete all applicable tests, certifications, forms, and matrices.
2. Heating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
3. Air Conditioning and Ventilating Work: Refer to Section 23 0500 "Basic HVAC Requirements".
4. Temperature Control Work: Refer to Section 23 0500 "Basic HVAC Requirements".
5. Fire Protection Work: Refer to Section 21 0500 "Basic Fire Suppression Requirements".
6. Testing, Adjusting, and Balancing Work: Refer to Section 23 0500 "Basic HVAC Requirements".

1.03 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. The Owner reserves the right to determine when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 ALTERNATES

A. Bakery equipment: Rough-in is part of Base Bid.

B. Laundry equipment: Rough-in is part of Base Bid where noted on drawings. Refer to drawings for additional information on scope.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
   a. Plumbing Contractor.
   b. Heating Contractor.
   c. Air Conditioning and Ventilating Contractor.
   d. Temperature Control Contractor.
   e. Fire Protection Contractor.
   f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
   a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
    a. Light fixtures.
    b. Gravity flow piping.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:
1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
    a. Burners.
    b. Condensing Units.
    c. Gas Trains.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.

3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
   a. Scale of drawings:
      1) General plans: 1/4 Inch = 1 '-0" (minimum).
      2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
      3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
      4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).
      5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
   a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
   b. Potential layout changes shall be made to avoid additional access panels.

c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.

2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa's Codes, Laws, Ordinances and other regulations having jurisdiction.

2. Conform to all State Codes.

3. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.

4. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.

5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.

6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.

7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as sewer and water and gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
    a. Any item listed as furnished shall also be installed, unless otherwise noted.
    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification Section	Submittal Item
22 05 00	Owner Training Agenda
22 05 15	Variable Frequency Drives
22 05 16	Expansion Compensation
22 05 29	Hangers and Supports
22 05 48	Vibration Isolation Equipment
22 05 53	Plumbing Identification
22 07 16	Plumbing Equipment Insulation
22 07 19	Plumbing Pipe Insulation
22 09 00	Instrumentation
22 10 00	Plumbing Piping Systems and Valves
22 10 23	Natural Gas and Propane Piping Systems
22 10 30	Plumbing Specialties
22 11 23	Domestic Water Pumps
22 12 00	Plumbing Tanks
22 30 00	Plumbing Equipment
22 40 00	Plumbing Fixtures

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number

f. Notations of deviations from the contract documents

g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

a. Date

b. Project title and number

c. Architect/Engineer

d. Contractor and subcontractors' names and addresses

e. Supplier and manufacturer's names and addresses

f. Division of work (e.g., plumbing, heating, ventilating, etc.)

g. Description of item submitted (using project nomenclature) and relevant specification number

h. Notations of deviations from the contract documents

i. Other pertinent data

j. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
   a. Submittal file name: 22 XX XX.description.YYYYMMDD
   b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

C. Coordinate the installation of heavy and large equipment with all contractors and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.13 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.14 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first manufacturer is the basis for job design and establishes the quality.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractor's part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (https://call811.com/) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.

5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. Utilities Bedding: Lay underground utilities on minimum of 6"sand bedding. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope around utilities to 6" above utilities: Place and compact sand to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
6. Dispose of excess excavated earth as directed.
7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.

2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.03 ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
   a. Pipe insulation is installed and fully sealed.
   b. Pipe wall penetrations are sealed.
   c. Pipe identification and valve tags are installed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.04 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div22.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, one paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.
16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Maintenance of equipment.
3. Start-up procedures for all major equipment.
4. Explanation of seasonal system changes.
5. Explanation of Owner’s Responsibilities to operate, maintain, and flush domestic water system (i.e., ASHRAE Standard 188).

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

F. Minimum hours of instruction for each item shall be:

1. Domestic Hot Water System - 2 hours
2. All Domestic Water Systems operation, maintenance and flushing of all fixtures and dead legs - 2 hours
3. Domestic Water Pressure Booster System - 4 hours.
4. Water Softener, Filtration and/or Purification System - 10 hours

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 SYSTEM STARTING AND ADJUSTING

A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.

D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.08 RECORD DOCUMENTS

A. The following paragraphs supplement Division 1 requirements.

B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices

located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.

D. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.09 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.

C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.

E. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

F. After surfaces have been thoroughly cleaned and are free of oil, dirt, and other foreign matter; paint all pipes and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Insulated Surfaces - Paint insulation jackets with two coats of semi-gloss acrylic latex paint.
3. Color of paint shall be as follows:
    a. All piping in mechanical room:
        1) Natural Gas: Yellow pipe/black letters

3.10 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.11 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Refer to Division 00 and Division 01 specifications for additional requirements which may include special requirements for work within the correctional facility.

E. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

1. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All pumps operating and balanced.
3. All plumbing fixtures installed and caulked.
4. Pipe insulation complete, pipes labeled and valves tagged.
5. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

SECTION 22 0505
PLUMBING DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Plumbing Demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.02 PREPARATION

A. Disconnect plumbing systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

C. Existing Plumbing System: Maintain service to all plumbing fixtures until new piping is installed. Obtain permission from Owner at least 48 hours before shutting down system for any reason. Make changeover to new piping with minimum outage. Do not disconnect any roof drainage piping until new piping is in place and operational.

3.03 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing plumbing work under provisions of Division 2 and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned piping to source of supply and/or main lines.

D. Remove exposed abandoned pipes, including abandoned pipes above accessible ceilings. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Extend existing installations using materials and methods compatible with existing installations, or as specified.

H. Remove unused sections of domestic water piping back to mains and cap. Capped pipe shall be less than 2 feet from main to prevent "dead legs".

I. Temporarily cap all openings to the sanitary and vent system to prevent odor from entering the work area and building.

3.04 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 22 0529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. PLUMBING ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.06 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 22 0513
MOTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single Phase and Three Phase Electric Motors.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.03 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.04 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories.

PART 2 - PRODUCTS

2.01 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. Design motors for continuous operation in 40ºC environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.

D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.

F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.

G. Each contractor shall set all motors furnished by him.

H. All motors shall have a minimum service factor of 1.15.

I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.

J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.

K. Motor Driven Equipment:

1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

2.02 ELECTRICALLY COMMUTATED MOTORS (ECM)

A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.

B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.

C. All EC motors shall be a minimum of 85% efficient at all speeds.

D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.

E. Provide motor with onboard motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.

F. Operational mode shall be as scheduled and shall be one of the following:

1. Constant Flow
2. Constant Temperature
3. Constant Pressure

2.03 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

A. All motors, unless exempted by EPAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
HP	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5

B. Motor nameplate shall be noted with the above ratings.

2.04 MOTORS ON VARIABLE FREQUENCY DRIVES

A. All motors driven by VFDs shall be premium efficiency type.

B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.

D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.

1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.
2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

END OF SECTION

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SECTION 22 0516
PLUMBING EXPANSION COMPENSATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Expansion Joints and Compensators.

B. Pipe Loops, Offsets, and Swing Joints.

1.02 REFERENCES

A. Conform to Standards of Expansion Joint Manufacturer's Association.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500.

B. Expansion joint shop drawings shall include maximum motion.

1.04 DESIGN CRITERIA

A. Unless noted otherwise, base expansion calculations on 50°F installation temperature to 140°F for domestic hot water, plus 30% safety factor.

PART 2 - PRODUCTS

2.01 EXPANSION JOINTS

A. Type EJ-1:

1. Multiple plies of 300 series stainless steel bellows.
2. Rated for 150 psi working pressure at 250°F and 100psi at 400°F.
3. Cycle life shall be at least 1,000 full range (compression and extension) cycles at rated stroke and 6,000 cycles at 1/2 rated stroke.
4. Axial motion shall be as scheduled on the drawings, but not less than 2" (compression plus extension).
5. Provide removable metal insulation shroud around the bellows.
6. Joints 2" or smaller in copper piping systems shall have all copper, brass or bronze construction with stainless steel bellows and union ends or sweat ends with unions added.
    a. Manufacturers:
        1) American BOA Type KH
        2) Hyspan Type 8509
        3) Flexonics Model HB
        4) Metraflex Model HPMF
        5) Keflex Series 7QT
7. Joints 2" or smaller in ferrous piping systems shall have steel bodies with union ends or male threaded ends with unions added.
    a. Manufacturers:
        1) American BOA Type B
        2) Hyspan Type 8503
        3) Flexonics Model H
        4) Metraflex Model HP Keflex Series 7Q-MPT
8. Joints 2-1/2" or larger shall have 150 lb. forged steel flanges.
    a. Manufacturers:
        1) American BOA Model 3150FS or 3150FL
        2) Hyspan Model 1501

3) RM Model X-Flex-150 Multiply
4) Keflex Series 311-1215
5) Metraflex Model MNLC

B. Alignment Guides:
1. Bolted semi-steel spider.
2. Bolted guiding cylinder with supporting legs welded to pipe support.
3. Sized to allow insulation to pass through the outer cylinder.
a. Manufacturers:
1) American BOA
2) Hyspan, Flexonics
3) Keflex
4) Metraflex

PART 3 - EXECUTION

3.01 INSTALLATION

A. Accomplish structural work and provide equipment required to control expansion and contraction of piping; including loops, offsets, swing joints, and expansion joints where required.

B. Rigidly anchor pipe to building structure where necessary. Provide pipe guides so all movement occurs along axis of pipe only.

C. Each expansion joint shall have either one anchor or two alignment guides on each side of it. Guides shall be located within 4 and 14 pipe diameters of the expansion joint or as recommended by the joint manufacturer.

D. Preset all expansion joints to allow for expected expansion from installation temperature to operating temperature.

END OF SECTION

SECTION 22 0529
PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.02 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 22 0500. Include plastic pipe manufacturers' support spacing requirements.

1.03 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to Division 3 Contractor for placement into formwork.

PART 2 - PRODUCTS

2.01 HANGER RODS

A. Hanger rods for single rod hangers shall conform to the following:

	Hanger Rod Diameter	
Pipe Size	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"
6"	3/4"	5/8"

Column #1: Steel and cast iron.

Column #2: Copper and plastic pipe.

B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.02 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, -69, -89, and -127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
3. Copper piping located in an exposed area, including indirect waste piping in kitchens and janitor's closets, shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

a. Products:
   1) Erico/M-Co Model #456
   2) B-Line Fig. 3198HCT
   3) Anvil Fig. CT138R
   4) Nibco/Tolco Fig. 301CT

B. Vertical Supports:
1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.
   a. Products:
      1) Cooper/B-Line Fig B3373 Series
      2) Erico 510 Series
      3) Nibco/Tolco Fig. 82
2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.
   a. Products:
      1) Mason RBA, RCA or RDA
      2) Mason BR
3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.
   a. Products:
      1) Pipeshields E100
4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.
5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:
1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.

5. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.
    a. Products:
        1) Anvil Fig. 160, 161, 162, 163, 164, 165
        2) Cooper/B-Line Fig. 3160, 3161, 3162, 3163, 3164, 3165.
        3) Erico Model 630, 631, 632, 633, 634, 635.
        4) Nibco/Tolco Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4
6. Unless otherwise indicated, hangers shall be as follows:
    a. Clevis Type:
        1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller
        2) Products: Bare Steel Plastic or Insulated Pipe:
            a) Anvil Fig. 260
            b) Cooper/B-Line Fig. 3100
            c) Erico Model 400
            d) Nibco/Tolco Fig. 1
        3) Products: Bare Copper Pipe:
            a) Cooper/B-Line Fig. B3100C
            b) Nibco/Tolco Fig. 81PVC
    b. Continuous Channel with Clevis Type: Service: Flexible Hose, Soft Copper Tubing:
        1) Products:
            a) Cooper/B-Line Fig. B3106, with Fig. B3106V
            b) Erico Model 104, with Model 104V
            c) Nibco/Tolco Fig. 1V
    c. Adjustable Swivel Ring Type:
        1) Service: Bare Metal Pipe - 4 inches and Smaller
        2) Bare Steel Pipe:
            a) Anvil Fig. 69
            b) Cooper/B-Line Fig. B3170NF
            c) Erico Model FCN
            d) Nibco/Tolco Fig. 200
        3) Bare Copper Pipe:
            a) Cooper/B-Line Fig. B3170CTC
            b) Erico 102A0 Series
            c) Nibco/Tolco Fig. 203
7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
    a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
   a. Clamp Type:
      1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller
      2) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
      3) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
      4) Bare Steel, Plastic or Insulated Pipe:
         a) Unistrut Fig. P1100 or P2500
         b) Cooper/B-Line Fig. B2000 or B2400
         c) Nibco/Tolco Fig. A-14 or 2STR
      5) Bare Copper Pipe:
         a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:
   1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
      a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):
         1) Products:
            a) Anvil Fig. 92
            b) Cooper/B-Line Fig. B3033/B3034
            c) Erico Model 300
            d) Nibco/Tolco 68
      b. Steel Structure Clamps: Scissor Type Beam Clamps (for use with bar-joists and wide flange):
         1) Products:
            a) Anvil Fig. 228, 292
            b) Cooper/B-Line Fig. B3054
            c) Erico Model 360
            d) Nibco/Tolco Fig. 329
      c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
         1) Products:
            a) MCL. M1, M2 or M3
      d. Concrete: Concrete Inserts, Single Rod Galvanized:
         1) Products:
            a) Anvil Fig. 282
            b) Cooper/B-Line Fig. B3014
            c) Erico Model 355
            d) Nibco/Tolco Fig. 310

e. Concrete: Concrete Inserts, Continuous Strip Galvanized:
   1) Products:
      a) Unistrut Corp P3200 Series
      b) Cooper/B-Line Fig. B22-J
      c) Erico CONCT

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

g. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

h. Steel Structure Welding:
   1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.03 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:
   1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
   2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):
   1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
   2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
   3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days.
   4. Equipment requiring bases is as follows:
      a. Expansion Tank
      b. Booster Pump
      c. Tank
      d. Water Heater
      e. Water Softener

C. Supports:
   1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
   2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.04 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the Division 3 Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

2.05 ROOF PENETRATIONS

A. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: Black shall match roofing membrane.

B. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

2.06 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.

F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.07 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.08 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.09 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.10 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.01 PLUMBING SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
   1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
   2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
      a. The hanger is attached within 6" from a web/chord joint.
      b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
   3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
   4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
   1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
      a. Maximum Spacing:
         1) 1-1/4" & under: 7'-0"
         2) 1-1/2": 9'-0"
         3) 2": 10'-0"
         4) 2-1/2": 11'-0"
         5) 3": 12'-0"
         6) 4" & larger: 12'-0"
   2. Steel (Std. Weight or Heavier - Vapor Service):
      a. Maximum Spacing:
         1) 1-1/4" and under: 9'-0"
         2) 1-1/2": 12'-0"
         3) 2" & larger: 12'-0"

3. Hard Drawn Copper & Brass (Liquid Service):
    a. Maximum Spacing:
        1) 3/4" and under: 5'-0"
        2) 1": 6'-0"
        3) 1-1/4": 7'-0"
        4) 1-1/2" 8'-0"
        5) 2": 8'-0"
        6) 2-1/2": 9'-0"
        7) 3": 10'-0"
        8) 4": 12'-0"
        9) 6": 12'-0"
4. Hard Drawn Copper & Brass (Vapor Service):
    a. Maximum Spacing:
        1) 3/4" & under: 7'-0"
        2) 1": 8'-0"
        3) 1-1/4": 9'-0"
        4) 1-1/2": 10'-0"
        5) 2": 11'-0"
        6) 2-1/2" & larger: 12'-0"
5. Plastic Pipe:
    a. Hangers shall be spaced based on the piping system manufacturer's instructions or, if no system instructions are available, space hangers at 4'-0" maximum centers.

I. Installation of hangers shall conform to MSS SP-58, -69, -89, and the applicable Plumbing Code.

END OF SECTION

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SECTION 22 0548
PLUMBING VIBRATION ISOLATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Vibration Isolation.

B. Flexible Connectors.

1.02 SUBMITTALS

A. Submit shop drawings per Section 22 0500 and the Vibration Isolation Submittal Form at the end of this section.

B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.

C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.

D. Isolator submittals shall include:

1. Equipment served
2. Type of Isolator
3. Load in Pounds per Isolator
4. Recommended Maximum Load for Isolator
5. Spring Constants of Isolators (for Spring Isolators)
6. Load vs. Deflection Curves (for Neoprene Isolators)
7. Specified Deflection
8. Deflection to Solid (at least 150% of calculated deflection)
9. Loaded (Operating) Deflection
10. Free Height
11. Loaded Height
12. Kx/Ky (horizontal to vertical stiffness ratio - for spring isolators)
13. Materials and Coatings
14. Spring Diameters

E. Make separate calculations for each isolator on equipment where the load is not equally distributed.

F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

PART 2 - PRODUCTS

2.01 BASIC CONSTRUCTION AND REQUIREMENTS

A. Vibration isolation for this project is subject to seismic restraint requirements of Section 22 0550.

B. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

C. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

D. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

E. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

F. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

G. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.

H. Provide motor slide rails for belt-driven equipment per Section 22 0513.

I. All isolators, except M1, shall have provision for leveling.

J. All components in contact with potable water shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act and NSF/ANSI-61 Low Lead Requirements for Drinking Water.

2.02 MOUNTINGS

A. Type M1:

1. 0.75" thick waffled neoprene pad with minimum static deflection of 0.07" at calculated load and 0.11" at maximum load. For loads less than 15 pounds, the deflection at calculated load requirement is waived, but the isolator must have a maximum stiffness of the ratio of 45#/0.35" .
2. Units need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators.
    a. Manufacturers:
        1) Mason "Super W"
        2) Kinetics "NGS"
        3) Amber/Booth "SPNR"
        4) Vibration Eliminator Co. "400N".

B. Type M2:

1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.
2. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.
3. All units shall have bolt holes and be bolted down.
4. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.
    a. Manufacturers:
        1) Mason Industries "ND" or "DNR"
        2) Amber/Booth "RVD"
        3) Kinetics "RD"
        4) Vibration Mountings and Controls "RD"
        5) Vibration Eliminator Co. "T22" or "T44".

C. Type M3:

1. Free standing, laterally stable spring isolators without housings and complete with 1/4" neoprene friction pads.
2. Units shall have bolt holes but need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators. Bolt holes shall not be within the springs.

3. All mountings shall have leveling bolts.
    a. Manufacturers:
        1) Mason "SLFH"
        2) Kinetics "FDS"
        3) Amber/Booth "SW-3, 4", 5" or 6"
        4) Vibration Eliminator Co. "OST".

D. Type M4:
1. Use restrained spring mountings for equipment with operating weight different from the installed weight.
2. Spring isolators shall be free-standing with 1/4" neoprene acoustical friction pads.
3. All units shall have bolt holes and be bolted down. Prevent short circuiting with neoprene bushings and washers between bolts and isolators.
4. All mountings shall have leveling bolts.
5. Housings with vertical resilient limit stops shall prevent spring extension when weight is removed. Housings shall serve as blocking during erection and the installed and operating heights shall be the same.
6. Maintain a minimum clearance of 1/2" around restraining bolts and between the housings and the springs so as not to interfere with the spring action.
7. Limit stops shall be out of contact during normal operation.
8. Select isolators for equipment subjected to wind loads in conformance with ASCE 7-02.
    a. Manufacturers:
        1) Mason "SLRS"
        2) Kinetics "FLS"
        3) Aeroflex "AWRS"
        4) Vibration Eliminator Co. "KW".

2.03 HANGERS

A. Type H1:
1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.
    a. Manufacturers:
        1) Mason "HD"
        2) Kinetics "RH"
        3) Aeroflex "RHD"
        4) Vibration Eliminator Co. "IC/3C/3CTD"
        5) Vibro Acoustics "RH"

B. Type H2:
1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.

4. Provide end connections for hanging ductwork or piping.
    a. Manufacturers:
        1) Mason "30"
        2) Kinetics "SRH"
        3) Amber/Booth "BSRA"
        4) Aeroflex "RSH"
        5) Vibration Eliminator Co. "SNC".
        6) Vibro Acoustics "SH/SHC"

C. Type H3:
1. Vibration hangers shall have a steel spring in a neoprene cup with a grommet to prevent short circuiting of the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Hangers shall be capable of holding the load at a fixed elevation during installation. They shall have a secondary adjustment to transfer the load to the spring and maintain the same position.
6. Deflection shall be indicated by a pointer and scale.
    a. Manufacturer:
        1) Mason "30N"
        2) Kinetics "SFH"
        3) Amber/Booth "BSW"
        4) Vibration Eliminator Co. "SNRC"
        5) Vibro Acoustics "SHR"

2.04 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

A. Type FC3:
1. Rated for minimum working pressures of 150 psi at 70°F and 100 psi at 800°F.
2. Sizes 2" and under shall be braided bronze hose with copper sweat ends or stainless steel braided hose with stainless steel threaded nipples,
3. Sizes 2-1/2" and over shall be stainless steel braided hose with 150 lb. stainless steel flanges.
4. Suitable for 1/2" permanent misalignment.
5. All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act and NSF/ANSI-61 Low Lead Requirements for Drinking Water.
    a. Manufacturers:
        1) Mason or Mercer "CPSB-NSF", "NSS-NSF" or "FLSS-NSF"
        2) Metraflex "BBSC", SSTT or "MMCC"
        3) Twin City Hose "ULTCHB", "UL-TCHSSMMT" or "ULTCHSSFLG"
        4) Flexible Metal Hose Company "BSW", "SSMN" or "SSMP"

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as pipes supported on a strut rack.

3.02 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. For base mounted pumps without resilient mountings, the first five hangers shall be Type H1.

C. Where piping is floor-supported, use M2 instead of H1 and M3 instead of H2.

D. Install flexible connectors in all piping connected to vibration producing equipment. This includes all base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.

E. Use Type FC3 for all potable water services. FC3 shall be installed parallel with equipment shafts.

F. Provide sufficient piping flexibility for vibrating equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.

G. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.

H. Support piping to prevent extension of flexible connectors.

3.03 VIBRATION ISOLATION SCHEDULE

A. Inline Pumps:

1. Base Type: NA
2. Isolator Type: M3 or H2 or H3
3. Static Deflection: 0.75"
4. Flexible Connections: NA

B. Base-Mounted Domestic Water Booster Pumps:

1. Base Type: Reuse existing
2. Isolator Type: Reuse existing
3. Static Deflection: 0.75"
4. Flexible Connections: FC-3

C. Air Compressor:

1. Base Type: NA
2. Isolator Type: M1
3. Static Deflection: NA
4. Flexible Connections: NA

END OF SECTION

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VIBRATION ISOLATION SUBMITTAL FORM

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12
		PROPOSED ISOLATOR							CALCULATIONS		
ITEM SERVED	MIN DEFL (")	TAG	MODEL	MAX LOAD (#)	DEFL @ MAX LOAD (")	DEFL TO SOLID (")	FREE HT (")	Kx/Ky	LOAD (#)	DEFL (")	DEFL RATIO

COLUMN NOTES: Note numbers correspond to the column numbers above.

1. Item served should match designation on the design drawings.
2. List the deflection scheduled or specified in the design documents.
3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
4. List the manufacturer's complete model designation for the isolator.
5. List the manufacturer's maximum rated load for the isolator.
6. List the isolator deflection at the maximum rated load in column 5.
7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

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SECTION 22 0553
PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Identification of products installed under Division 22.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

1. 3M
2. Bunting
3. Calpico
4. Craftmark
5. Emedco
6. Kolbi Industries
7. Seton
8. W.H. Brady
9. Marking Services

2.02 MATERIALS

A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
2-1/2" to 6"	12"	1-1/4"
Plastic tags may be used for outside diameters under 3/4"		

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

D. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

E. Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape 6" wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item.

F. Tracer Wire:

1. Single copper conductors shall be solid or stranded annealed or hard uncoated copper per UL83 and ASTM requirements. Tracer tape or copper-coated steel wire is not acceptable.
2. Conductor shall be insulated with HMWPE as specified and applied in a concentric manner. The minimum at any point shall not be less than 90% of the specified average thickness in compliance with UL 83.
3. Tracer wire shall be continuously spark tested at 7500 Volts DC. Other electrical and mechanical tests shall be in accordance with UL 1581.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.
2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
6. Number all tags and show the service of the pipe.
7. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Apply markers and arrows in the following locations where clearly visible:
   a. At each valve.
   b. On both sides of walls that pipes penetrate.
   c. At least every 20 feet along all pipes.
   d. On each riser and each leg of each "T" joint.
   e. At least once in every room and each story traversed.
3. Underground Pipe Markers: Install 8" to 10" below grade, directly above buried pipes.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Provide engraved plastic tags at all hydronic or steam system makeup water meters.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Tracer Wire:

1. Tracer wire shall be installed on top of all non-metallic buried utilities.
2. Tracer wire shall be taped directly to plastic water or drain pipe.
3. Tracer wire shall not be fastened directly or indirectly to gas piping.
4. Tracer wire when attached shall be secured to the pipe a minimum of every 10 feet and at all changes of direction.
5. Tape shall be Polyken "930-35", Protecto-Wrap "310", or approved equal.
6. Tracer wire shall be continuous between boxes and shall be tested for continuity.
7. Splices in tracer wire shall be made with a water proof splice kit to prevent corrosion. Wire nuts shall not be used.
8. The tracer wire shall daylight to grade through a 2" PVC conduit, at the point of the utility entrance to building. PVC conduit shall be capped and labeled as future contact point to locate the utility.

3.02 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. CONDENSATE DRAIN: White lettering; green background
2. DOMESTIC COLD WATER: White lettering; green background
3. DOMESTIC HOT WATER - 140°F: White lettering; green background
4. DOMESTIC HOT WATER CIRCULATING - 140°F: White lettering; green background
5. SANITARY SEWER: Black lettering; yellow background
6. VENT: Black lettering; yellow background
7. NATURAL GAS: Black lettering; yellow background
8. TEMPERED WATER: White lettering; green background
9. All Underground Pipes: Varies
10. Tracer Wire - Natural Gas Pipe Lines: Black lettering; yellow background
11. Tracer Wire - All other buried types: White lettering; green background

B. Non-Potable Piping: All piping conveying non-potable water shall be permanently identified by continuously painted or continuous adhesive backed marker along entire length of pipe and branches so the piping is readily distinguishable from piping carrying potable water. Pipe markers shall be located as described above.

1. NON-POTABLE WATER: White lettering; purple background
2. RO WATER: White lettering; purple background

END OF SECTION

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SECTION 22 0716
PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Equipment Insulation.

B. Equipment Insulation Finishes.

1.02 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500. Include product description, list of materials and thickness for equipment scheduled.

PART 2 - PRODUCTS

2.01 INSULATION

A. Type B: Glass Fiber Board; ANSI/ASTM C612; 0.28 maximum 'K' value at 200°F; 6.0 lb./cu ft; suitable to 850°F, 25/50 flame spread/smoke developed.

B. Type C: EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

2.02 INSULATION FINISHES

A. Type 1: Glass Fabric; ASTM D1668, woven glass fabric with two coats of mastic approved for insulation type. Use vapor barrier mastic on system requiring a vapor barrier.

B. Type 2: All Service Jacket; ASTM C921; Factory or Field Applied; all-purpose polymer or polypropylene service jacket; Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Seal all joints with manufacturer approved tape and adhesive to maintain vapor barrier. Indoor use only, if used outdoors add type 4 finish.

C. Type 3: Flexible Elastomeric Thermal Insulation; After adhesive has fully cured, apply two coats of latex enamel paint approved by insulation manufacturer for outdoor use.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all materials per manufacturer's instructions, codes and industry standards.

B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.

C. Do not insulate factory insulated equipment.

D. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.

E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.

F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.

G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.

H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.

I. Insulate all equipment surfaces that are not factory insulated and are intended to operate below 60°F and/or above 100°F. Verify insulation type and thickness with equipment manufacturer and Architect/Engineer.

J. Insulate all supports on equipment operating below ambient temperature.

3.02 INSULATION

A. Type B:

1. Apply with edges tightly butted and joints staggered.
2. Secure with welded pins and washers, 4" from each edge and 16" on center, or 1/2" x 0.015" galvanized steel bands, 12" on center.

B. Type C:

1. Apply with edges tightly butted and joints staggered. Install multiple layers if required thickness is greater than 1" thick.
2. Secure with manufacturer approved adhesive. Seal all joints with manufacturer approved adhesive.

3.03 SCHEDULE

A. Domestic Hot Water Storage Tank (up to 250°F): 2" thick Type B; Finish 1 or 2.

B. RO Pneumatic Pressure/Storage Tank:

1. 1" thick Type B; Finish 1 or 2
2. 1" thick Type C, Finish 3.

C. Water Softener Tank:

1. 1" thick Type B, Finish 1 or 2
2. 1" thick Type C, Finish 3.

END OF SECTION

SECTION 22 0719
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping Insulation.

B. Insulation Jackets.

1.02 QUALITY ASSURANCE

A. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.01 INSULATION

A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.29 maximum 'K' value at 75°F; density 7.3lb/ft; minimum compressive strength 90 psi parallel to rise; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations, use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose polymer or polypropylene service jacket for above grade installations.

D. Type E: Preformed rigid cellular polyisocyanurate insulation; ANSI/ASTM C591; maximum 'K' value of 0.19 at 75°F; density 4.0lb/ft; minimum compressive strength 95 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -297°F to +300°F.

2.02 VAPOR BARRIER JACKETS

A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

2.03 JACKET COVERINGS

A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

3.02 INSTALLATION

A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.

B. Insulated Piping Operating Below 60°F:

1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

3.03 SUPPORT PROTECTION

A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.

B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
    a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    b. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" to 10". For pipe sizes larger than 10", provide rolled steel plate in addition to the shield Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall be listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
    c. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.

d. Phenolic (for pipes operating below 250°F with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.

e. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.

1) Products:

a) Buckaroo CoolDry

b) Cooper/B-Line Fig. B3380 through B3384

c) Pipe Shields A1000, A2000

f. Insulation Couplings:

1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.

2) Horizontal Strut Mounted Insulated Pipe Manufacturers:

a) Klo-Shure or equal

3) Vertical:

a) Manufacturers: Klo-Shure Titan or equal

g. Rectangular blocks, plugs, or wood material are not acceptable.

h. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5” to 6"	18" long x 16 gauge

F. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

3.04 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.

2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.

3. Apply insulation with laps on top of pipe.

4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
    a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
    b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
    a. Install preformed sections of same material as straight segments of pipe insulation when available.
    b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
    c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type C Insulation:

1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
2. Insulate fittings with prefabricated fittings.

D. Type E Insulation:

1. Indoors, above grade or below grade, Polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
2. Insulate pipe fittings with prefabricated insulation fittings.

3.05 JACKET COVER INSTALLATION

A. Plastic Covering:

1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. All joints in areas noted shall meet USDA standards for Totally Sealed Systems, including overlaps of 1" on circumferential and 1.5" to 2" on longitudinal seams.

5. Use plastic insulation covering on all exposed pipes including, but not limited to:
   a. All exposed piping below 8'-0" above floor.
   b. All piping in mechanical rooms and/or tunnels that are subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
   c. All kitchen areas.

3.06 SCHEDULE

A. Refer to drawings for insulation schedule.

END OF SECTION

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SECTION 22 0900
INSTRUMENTATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pressure Gauge.

B. Pressure Gauge Accessories.

C. Thermometers.

D. Test Plugs.

1.02 SUBMITTALS

A. Submit shop drawings per Section 22 0500. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.

1. Manufacturers:
    a. Ashcroft
    b. Marsh
    c. Marshalltown
    d. Miljoco
    e. Trerice
    f. U.S. Gauge Figure 1901
    g. Weiss
    h. Weksler
    i. Wika.

B. Select gauge range for normal reading near center of gauge.

2.02 PRESSURE GAUGE ACCESSORIES

A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.

B. Shutoff Valve: 1/4" ball valve as specified for each piping system.

C. Pressure snubber, brass with 1/4" connections, porous metal type.

2.03 THERMOMETERS

A. Alcohol/Spirit Filled Type:

1. 9" long phenolic case, steel stem, accuracy of 1% full scale. Adjustable elbow joint with 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal plane, and locking device to allow rotation of thermometer to any angle.
2. Select thermometer for appropriate temperature range.
3. Stem: Copper plated steel, aluminum, or brass for separable socket. Stem lengths as required for application with minimum insertion of 3-1/2".
4. Thermometers for water shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

5. Manufacturer:
    a. Marsh
    b. Miljoco
    c. Trerice
    d. Weiss
    e. Weksler
    f. Wika.

B. Select scales to cover expected range of temperatures.

2.04 TEST PLUGS

A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.

B. Provide extended units for all plugs installed in insulated piping.

C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" diameter pressure gauge with 0-100 psi range, one gauge adapter with 1/8" probes, two 1-1/2" dial thermometers with 0° to 220°F and -25°F to 125°F ranges and 5" stems.

D. Manufacturers:
    1. Sisco
    2. Flow Design
    3. Peterson Equipment
    4. MG Piping Products Co.
    5. Miljoco
    6. Trerice
    7. Watts Regulator.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:
    1. Install per manufacturer's instructions.
    2. Coil and conceal excess capillary on remote element instruments.
    3. Install gauges and thermometers in locations where they are easily read from normal operating level.
    4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Pressure Gauges:
    1. Connect pressure gauges to suction and discharge side of all pumps.
    2. Provide snubber for each pressure gauge.

C. Thermometers:
    1. Install piping system thermometers in sockets with short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
    2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.

END OF SECTION

SECTION 22 1000
PLUMBING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe and Pipe Fittings.

B. Valves.

C. Check Valves.

1.02 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

1.05 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 0500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.01 CAST IRON PIPE

A. Cast Iron; Standard Weight; Hub and Spigot Joints:

1. Pipe: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888.
2. Design Pressure: Gravity Maximum Design Temperature: 180°F
3. Joints: Compression gasket, ASTM C564.
4. Restraints: Install pipe and fittings per the Cast Iron Soil Pipe Institute's Designation 301. Restrain pipe and fittings using an engineered and tested product manufactured for restraining no-hub cast iron soil pipe. Install per manufacturer's recommendations.
5. Adapters: Heavy duty no-hub transition for joining cast iron and PVC pipe. Adapters shall be tested and certified to ASTM C 1460 and be constructed with Type 304 stainless steel shield, thickness 0.015" shield, gasket material to meet ASTM C564, 1-1/2" to 4" will be 3" wide with four 304 stainless steel bands, and 6" to 10" will be 4" wide with six 304 stainless steel bands and 3/8" 305 stainless steel hex head screws torqued to 80 inch pounds.

2.02 COPPER PIPE

A. Copper Pipe; Type L; Solder Joints:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

B. Copper Pipe; Type L; Mechanical Press Connection:
   1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
   2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
   3. Joints: Mechanical press connection.
   4. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
   5. Manufacturers:
      a. Viega ProPress
      b. Elkhart Xpress
      c. Nibco Press System Fittings and Valves
      d. Mueller Streamline PRS

C. Copper Pipe; Type K; Solder Joints:
   1. Pipe: Type K annealed copper tube, ASTM B88.
   2. Design Pressure: 150 psi. Maximum Design Temperature: 200°F.
   3. Joints: Solder with 100% lead-free solder and flux ASTM B32 BCuP silver braze, AWS A5.8.
   4. Fittings: Wrought copper solder joint, ANSI B16.22.

D. Copper Pipe: Type M; Solder Joints:
   1. Pipe: Type M hard temper seamless copper drainage tube, ASTM B306.
   2. Design Pressure: Gravity Maximum Design Temperature: 180°F
   3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
   4. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

2.03 PLASTIC PIPE

A. Cross-Linked Polyethylene (PEX); Cold Expansion Joint:
   1. Tubing: Cross-linked polyethylene (PEX-a or PEX-b), SDR-9, ASTM F876, NSF Certified
   2. Design Pressure/Temperature: 100 psig at 180°F.
   3. Joints: Bending the tubing greater than eight (8) times the outside diameter shall be permitted. Bends less than eight (8) times the outside diameter shall be barbed insertion fittings provided by the manufacturer.
   4. Fittings: Cold expansion joint compatible with engineered polymer or lead-free brass construction. System shall conform to ASTM F1960. Fittings for Reverse Osmosis water shall be engineered polymer.
   5. Limitations: Shall not be used in a return air plenum unless specifically listed to ASTM E84/UL723.

B. Virgin Rigid Chlorinated Polyvinyl Chloride (CPVC); Schedule 80; Solvent Weld Joints:
   1. Tubing: Virgin rigid chlorinated polyvinyl chloride (CPVC). Iron Pipe Size (IPS) Schedule 80 with a cell class of 23447-B, ASTM D1784, NSF Certified.
   2. Design Pressure/Temperature: 100 psig at 180°F for 2-1/2" pipe, 185 psig at 140°F for 3" pipe, 160 psig at 140°F for 4" pipe, 140 psig at 140°F for 6" pipe, 125 psig at 140°F for 8" pipe.
   3. Joints: Solvent cement, ASTM F493.
   4. Fittings: Same as tubing. Fittings and tubing shall be a system provided by the same manufacturer.
   5. Limitations: Shall not be used in a return air plenum unless specifically listed to ASTM E84/UL723.
   6. Special Requirements: Provide expansion loop(s) and/or Schedule 80 expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 0516 for expansion joint requirements.

C. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints:

1. Pipe: Schedule 40 rigid, PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
3. Fittings: PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
4. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
6. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 0516 for expansion joint requirements.

D. Chlorinated Polyvinyl Chloride (CPVC); Schedule 40 Drainage; Solvent Weld Joints:

1. Pipe: Chlorinated polyvinyl chloride (CPVC) Schedule 40 drainage pipe, ASTM F1412, NSF Listed.
2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer, ASTM F493.
3. Fittings: Chlorinated polyvinyl chloride (CPVC) DWV pattern with socket ends for Schedule 40 pipe.
4. Limitations: CPVC shall not be used in a return air plenum unless it is specifically listed to ASTM E84 and/or UL723. CAN ULC S102.2 listing is not acceptable.
5. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 0516 for expansion joint requirements.

2.04 STAINLESS STEEL PIPE

A. Stainless Steel; Schedule 5; Type 304; Mechanical Press Connection:

1. Pipe: Schedule 5 Type 304 stainless steel, ASTM A312 and ASTM A554 in copper tube size conforming to ASTM B88.
2. Joints: Mechanical press connections.
3. Fittings: Type 304 stainless steel, ASTM B88 and ANSI B16.22 with embedded O-ring. NSF-61 stainless steel grip ring for 2 1/2" to 4" diameter sizes.
4. Transitions to other materials: Provide dielectric connection as required in this section. Refer to article "CONNECTIONS BETWEEN DISSIMILAR METALS."
5. Special Requirements: Mechanical press fitting manufacturer shall provide contractor training prior to installation.
6. Manufacturers:
   a. Viega ProPress

B. Stainless Steel; Type 316; Hub and Spigot Joint:

1. Pipe: Stainless Steel Type 316L, ASME A112.3.1
2. Design Pressure: Gravity. Design Temperature: 200°F minimum.
3. Fittings: Stainless Steel Type 316L, ASME A112.3.1, push-on joints.
4. Joints: Push-on joint with integral rubber gaskets suitable for use with greasy waste typical for kitchen grease sanitary applications.
5. Adapters: Transition from stainless steel pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C564, 300 Series stainless steel shield, clamp and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

6. Manufacturers:
    a. Blucher
    b. Watts
    c. Josam
    d. Approved equivalent

2.05 VALVES

A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Butterfly Valves:
    a. BF-1:
        1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 250°F at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1P, Stockham LD712-B&3-E, Nibco LD2000N Series, Milwaukee CL series, Hammond 5200 series.
        2) 8" thru 12", 175# CWP, elastomers for 20°F to 225°F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator. Center Line Series 200, Keystone #222, Watts #DBF-03-121-1G, Stockham LD722-B&3-E, Nibco LD2000N Series, Milwaukee CL series, Hammond 5200 series.
3. Ball Valves:
    a. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
        1) Provide solid extended shaft for all insulated piping.
        2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.
    b. BA-7: 2" and under, 125 psi at 95°F, 35 psi at 140°F, socket weld, PVC, true union ball valve with PTFE ball seats, EPDM O-ring seals. George Fischer 346, Asahi Omni, Nibco Tru-bloc.

B. Throttling Valves

1. Globe Valves:
    a. GL-1: 2" and under, 150# saturated steam, 300# CWP, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413T, Watts #B-4010-T, Nibco T-235Y.
    b. GL-2: 2-1/2" thru 10", 125# steam @ 353°F, 200# CWP @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #8906F, Milwaukee #F2981, Watts #F-501, Nibco F-718B.

2.06 STRAINERS

A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

B. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @ 150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT, Watts #777.

C. ST-7: 2-1/2" thru 8", bronze body, flanged ends, flanged cover, 150# steam, 225# CWP. Mueller Steam Specialty Co. #851.

2.07 CHECK VALVES

A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

B. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.

C. CK-14: 2-1/2" thru 12", 200# CWP, double disc wafer type, bronze or iron body, bronze trim, metal-to-metal or Viton seat, 316 SS shaft, Inconel 600 spring. Mission Duo Chek #12HPP (with Inconel springs), Mueller Steam Specialty Co. #71-AHB-K-W, Stockham #WG-961-EPDM or #WG-970-BUNA, Nibco w-920-W.

2.08 LOCK OUT TRIM

A. Provide lock out trim for all quarter turn shutoff valves opening to atmosphere and installed in domestic water piping over 120°F and as indicated on the drawings.

2.09 VALVE OPERATORS

A. Provide handwheels for gate valves and gear operators for butterfly valves.

2.10 VALVE CONNECTIONS

A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

2.11 CONNECTIONS BETWEEN DISSIMILAR METALS

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron and steel connected to each other.
2. Brass, copper, and bronze connected to each other.
3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.
2. Manufacturers:
   a. Elster Group ClearFlow fittings
   b. Victaulic Series 647
   c. Grinnell Series 407
   d. Matco-Norca

F. Flanged Joints (any size):
   1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
   2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
   3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
   4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
   5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
   6. Manufacturers:
      a. EPCO
      b. Central Plastics
      c. Pipeline Seal and Insulator
      d. F. H. Maloney
      e. Calpico

PART 3 - EXECUTION

3.01 PREPARATION

A. Install all products per manufacturer's recommendations.
B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
C. Remove scale and dirt, on inside and outside, before assembly.
D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
E. Connect to equipment with flanges or unions.
F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
G. Roof Penetration (Vent) Flashing:
   1. Membrane, Metal or Shingled Roofs: Flash vents with premolded pipe flashing cones for single-ply membrane roofs, metal roofs, or shingled roofs.

3.02 SYSTEM, PIPING AND VALVE SCHEDULE

A. Cold Water, Hot Water, Tempered Water - Potable and Non-Potable (Above Ground):
   1. Copper Pipe; Type L; Solder Joints: All Sizes
   2. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
   3. Stainless Steel; Schedule 5; Type 304; Mechanical Press Connection: 4" and Under
   4. Cross-Linked Polyethylene (PEX); Cold Expansion Joints: 3" and Under
   5. Virgin Rigid Chlorinated Polyvinyl Chloride (CPVC); Schedule 80; Solvent Weld Joints: 2-1/2" to 8"
   6. Shutoff Valves: BF-1, BA-1
   7. Throttling Valves: GL-1, GL-2
   8. Check Valves: CK-1, CK-14
   9. Strainers: ST-1, ST-7
B. Cold Water, Hot Water - Potable (Underground):
   1. Copper Pipe; Type K; Solder Joints: All Sizes
   2. Cross-Linked Polyethylene (PEX); Cold Expansion Joint: 3" and Under

C. Sanitary Waste and Vent, Gravity (Above Ground):
   1. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes

D. Sanitary Indirect Drainage (Above Ground):
   1. Copper Pipe: Type M; Solder Joints: 1-1/4" to 4"

E. Sanitary Waste and Vent, Gravity (Underground - Inside Building):
   1. Cast Iron; Standard Weight; Hub and Spigot Joints: All Sizes
   2. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes - not allowed for any waste water piping from trench drain in laundry room through lint interceptor or in 6" sanitary main until it connects to 6" sanitary main in Corridor 1210. Not allowed in sanitary piping from dishwasher drain #192 until it reaches 6" main in Passage 1208

F. Kitchen Grease Drainage and Vent (Above Ground):
   1. Stainless Steel; Type 316; Hub and Spigot Joint: 2" to 8"
   2. Chlorinated Polyvinyl Chloride (CPVC); Schedule 40 Drainage; Solvent Weld Joints

G. Kitchen Grease Drainage and Vent (Underground):
   1. Stainless Steel; Type 316; Hub and Spigot Joint: 2" to 8"
   2. Chlorinated Polyvinyl Chloride (CPVC); Schedule 40 Drainage; Solvent Weld Joints. (Not allowed on piping receiving discharge from steamers and rack ovens where noted on drawing

H. Reverse Osmosis:
   1. Cross-Linked Polyethylene (PEX); Cold Expansion Joints: 3" and Under. Fitting shall be plastic, not lead free brass construction.
   2. Shutoff Valves: BA-7

I. Condensate/Equipment Drainage:
   1. Copper Pipe: Type M; Solder Joints: 1-1/4" to 4"

3.03 TESTING PIPING

A. Sanitary Drainage, Sanitary Vent:
   1. Test all piping with water to prove tight.
   2. Test piping before insulation is applied.
   3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
   4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
   5. A smoke/air test at the same pressure may be used in lieu of the hydrostatic water test. Exception: Smoke/air test shall not be performed on plastic piping.
   6. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.
   7. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.

B. Hot Water - Potable and Non-Potable, Cold Water - Potable and Non-Potable:
   1. Test pipes underground or in chases and walls before piping is concealed.
   2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
   3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
   4. Hold test pressure for at least 2 hours.
   5. Test to be witnessed by the Architect/Engineer's representative, if requested by the Architect/Engineer.

C. All Other Piping:

1. Test piping at 150% of normal operating pressure.
2. Piping shall hold this pressure for one hour with no drop in pressure.
3. Test piping using water, nitrogen, or air as compatible with the final service of the pipe. Do not use combustible fluids.
4. Drain and clean all piping after testing is complete.

3.04 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. All Water Piping:

1. Flush all piping using faucets, flush valves, etc. until the flow is clean.
2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

3.05 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Install bell and spigot piping with bells upstream.
7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
8. Seal pipes passing through exterior walls with a wall seal per Section 22 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
9. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.
10. All vertical pipe drops to sinks or other equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

C. Installation Requirements in MRI (Magnetic Resonance Imaging - Healthcare):

1. All piping in MRI rooms shall be non-ferrous regardless of materials described on Part 2.

D. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
2. Provide clearance for installation of insulation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.
5. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.
6. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

E. Underground Piping:

1. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements

F. Sanitary Piping:

1. Install all sanitary piping inside the building with a slope as shown on the drawings.
2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
3. Slope sanitary piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.
4. Sway Bracing: Where horizontal sanitary pipes 4 inches and larger change flow direction greater than 45°, rigid bracing or thrust restraints shall be installed to resist movement of the upstream pipe in the direction of pipe flow. The rigid bracing or thrust restraint shall be connected to structure. A change of flow direction from horizontal into a vertical pipe does not require the upstream pipe to be braced.
5. All sanitary piping shall have at least 42" of cover when leaving the building.
6. Starter fittings with internal baffles are not permitted.

3.06 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.

B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.

D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.

E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.

F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.

G. Provide flanges or unions at all final connections to equipment, traps and valves.

H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.

I. Use full and double lengths of pipe wherever possible.

J. Unless otherwise indicated, install all piping, including shutoff valves and strainers to coils, pumps, and other equipment at line size with reduction in size being made only at control valve or equipment.

K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.

L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements.

M. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.

N. Do not use geotextile fabric with footing tile if silt content of soil exceeds 40% or if clay content exceeds 50%. The fabric shall be installed around 1" river rock or 2" limestone.

3.07 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal water lines, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate and venting.

B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.

C. Provide drain valves at all low points of water piping systems for complete or sectionalized draining.

D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.

E. Provide air vents at high points and wherever else required to eliminate air in all water piping systems.

F. Install air vents in accessible locations. If necessary to trap and vent air in a remote location, install an 1/8" pipe from the tapping location to an accessible location and terminate with a venting device.

G. All vent and drain piping shall be of same materials and construction for the service involved.

3.08 PLUMBING VENTS

A. Vent as shown on the drawings and in accordance with all codes having jurisdiction.

B. Extend the high side of the soil and waste stacks at least 12" above roof.

C. Flash pipes at roof with premolded EPDM pipe flashing cones adhered to roof membrane by Roofing Contractor. Secure top of cone with stainless steel clamp and seal watertight.

D. Increase vent pipes through the roof two pipe sizes with long increasers located at least 12" below the roof.

E. In no case shall the vent through the roof be less than 4" in diameter.

F. Vent pipes through the roof shall be located a minimum of 10 feet from any air intake opening on the roof.

3.09 BRANCH CONNECTIONS

A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Do not use double wye or double combination wye and eighth bend DWV fittings in horizontal piping.

D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:

1. Domestic water piping above ground.

E. Further limit use of mechanically formed fittings as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be Type K or L copper tubing.
   3. Permanent marking shall indicate insertion depth and orientation.
   4. Branch pipe shall conform to the inner curve of the piping main.
   5. Main must be 1" or larger.
   6. Branch must be 3/4" or larger.

F. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

G. Forged weld-on fittings are limited as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be 2-1/2" or larger.
   3. Branch line is at least two pipe sizes under main size.

3.10 JOINING OF PIPE

A. Solder Joints (Copper Pipe):
   1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
   2. Flux shall be non-acid type.
   3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

B. Brazed Joints (Copper Pipe):
   1. Make up joints with silver alloy brazing filler metal conforming to ASTM B260 "Brazing Filler Metal" BAg-1 or BAg-2. Cut copper tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to brazing. Apply non-corrosive flux of the type recommended by filler alloy manufacturer, evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly using oxygen-acetylene torch with tip size recommended by fitting manufacturer. Wipe and brush joint clean after alloy has set.
   2. Remove discs from solder end valves during brazing.

C. Mechanical Press Connection (Copper and Stainless Steel Pipe):
   1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
   2. Fully insert tubing into the fitting and mark tubing.
   3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
   4. Joint shall be pressed with a tool approved by the manufacturer.
   5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

D. Solvent Weld Joints (PVC):
   1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.

E. Solvent Weld Joints (CPVC):

1. Make joints with a one-step process. Use CPVC cement conforming to ASTM F493. A primer is not required.
2. If a primer is required by the Authority Having Jurisdiction, then a primer conforming to ASTM F656 shall be used.

F. Cold Expansion Joint (PEX):

1. Cold expansion joints shall be made in accordance with manufacturer's installation instructions.
2. All installers shall undergo training provided by the manufacturer or manufacturer's representative.

3.11 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfection of the domestic water piping shall be completed within three (3) weeks prior to building occupancy. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed within two (2) weeks prior to building occupancy.

B. Provide necessary connections at the start of individual sections of mains for adding chlorine.

C. Before starting work, verify system is complete, flushed and clean.

D. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

F. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.

G. Verify initial chlorination levels by testing at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main.

H. Maintain disinfectant in system for 24 hours, after which test at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.

I. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet/second until residual is equal to that of incoming water or 1.0 mg/L.

J. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

3.12 SERVICE CONNECTIONS

A. Provide new sanitary sewer services. Before commencing work check invert elevations needed for sewer connections, confirm inverts and verify these can be properly connected with slope for drainage and cover to avoid freezing.

END OF SECTION

SECTION 22 1023
NATURAL GAS PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pipe and Pipe Fittings.

B. Valves.

C. Natural Gas Piping System.

1.02 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 22 05 00. Include data on pipe materials, fittings, valves, and accessories.

B. Test Reports: Provide results of piping system pressure test.

C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.

B. Deliver and store valves in shipping containers with labeling in place.

1.05 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.01 NATURAL GAS (0 to 125 PSI)

A. Design Pressure: 125 psi. Maximum Design Temperature: 350°F

B. Piping - 2" and Under:

1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.
2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)
3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.

C. Piping - 2" and Under:

1. Pipe: Corrugated stainless steel tubing, ASTM A240 Series 300 stainless steel, ANSI AGA-LC1.
2. Jacket: Polyethylene.
3. Fittings: Brass with mechanical ends to fit tubing. ASME B1.20.1 threaded ends for connections to threaded pipes and components.
4. Striker Plates: Minimum 16 gauge hardened steel, corrosion resistant, primed and zinc coated. Install to protect tubing from penetrations.
5. Limits: 5 psi or less. For use only at termination to fixed outlets or equipment, maximum length: 48". Provide malleable iron, flange mounted, straight or 90 fitting at wall termination with maximum 12" length of tubing on inlet of flange.

6. Manufacturers:
    a. TracPipe
    b. Gastite
    c. Parker (Parflex)
    d. Proflex (1 Yellow CSST)

D. Piping - 2-1/2" and Over:
1. Pipe: Standard weight steel, beveled ends, ASTM A53.
2. Joints: Butt welded or flanged.
3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.

E. Piping - All Sizes:
1. Pipe: Polyethylene pipe, ASTM D2513, SDR 11.5.
2. Joints: Fusion welded.
3. Fittings: Socket type, ASTM D2683 or ASTM D2513.
4. Limits: Use only below ground outside of buildings.
5. Transition Riser (Polyethylene to Steel Transition):
    a. Provide transition riser fitting by Central or equal when offsetting from below grade polyethylene to above grade Schedule 40 black steel piping.
    b. Joints: ASTM A53 Schedule 40 steel epoxy coated casing welded or threaded end; the polyethylene end shall be fusion welded.

F. For Underground Gas Piping - Refer to paragraph "Underground Piping Protection."

G. Shutoff Valves/Throttling Valves:
1. BA-13: 2" and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing.
    a. Manufacturers:
        1) Apollo #80-100
        2) Nibco #T580-70-UL or #T585-70-UL
        3) Watts #B-6000
2. PL-1: 2" and under, 125# steam @ 450°F, 175# CWP @ 180°F, cast iron body, screwed, full port.
    a. Manufacturers:
        1) Walworth #1700
        2) DeZurik #425, S-RS49
3. PL-2: 2-1/2" thru 4", 125# steam @ 450°F, 175# CWP @ 180°F, flanged, cast iron body, full port.
    a. Manufacturers:
        1) Walworth #1700F
        2) DeZurik #425, F-RS49

H. Check Valves:

1. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing.
    a. Manufacturers:
        1) Crane #37
        2) Hammond #IB904
        3) Stockham #B319-Y
        4) Walworth #3406
        5) Milwaukee #509
        6) Watts #B-5000
        7) Nibco Y-413B
2. CK-13: 2-1/2" thru 12", 200# CWP, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.
    a. Manufacturers:
        1) Mueller Steam Specialty Co. #71-AHB-6-H
        2) Stockham #WG-961 EPDM or #WG970 BUNA
        3) NIBCO W-920-W
        4) Crane

I. Strainers:

1. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 350°F, 175 psi CWP @ 150°F.
    a. Manufacturers:
        1) Armstrong #A1FL
        2) Metraflex #TF
        3) Mueller Steam Specialty Co.#751
        4) Sarco #CI-125
        5) Watts #77F-D
2. ST-4: Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 300# CWP @ 150°F.
    a. Manufacturers:
        1) Armstrong #A1SC
        2) Metraflex #SM
        3) Mueller Steam Specialty Co. #11
        4) Sarco #IT

2.02 STRAINERS

A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

1. Gases:
    a. 1/4" - 2": 1/32" perforations
    b. 2-1/2" - 10": 3/64" perforations

B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.

C. Use iron body strainers in ferrous piping.

2.03 DRAIN VALVES AND BLOWDOWN VALVES

A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

D. Connect to all equipment with flanges or unions.

E. After completion, fill, clean, and treat systems. Refer to Section 23 2500 for treatment.

3.02 TESTING PIPING

A. Low Pressure - Up to 1 psi:

1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.

B. High Pressure - Above 1 psi:

1. Test piping with compressed air at twice the operating gas pressure, but at least 20 psi. System must hold this pressure without adding air for two hours.

C. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

3.03 CLEANING PIPING

A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.

2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.

3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.

4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

3.04 INSTALLATION

A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.

B. Install piping to conserve building space, and not interfere with other work.

C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

D. Group piping whenever practical at common elevations.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Install thrust blocking and restraints on all buried piping at elbows and other changes in pipe direction.

G. Provide chain operators for all valves over 2" size that are over 10'-0" above finished floor. Extend to 7'-0" above finished floor.

H. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.

I. Provide clearance for access to valves and fittings.

J. Provide access doors where valves are not exposed.

K. Prepare pipe, fittings, supports, and accessories for finish painting.

L. Install valves with stems upright or horizontal, not inverted.

M. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.

N. Provide shutoff valves to isolate part of systems and vertical risers.

O. Provide shutoff valves to boilers and water heaters in readily accessible location, maximum 6 feet above finished floor, within 6 feet of boiler connection per ASME CSD-1.

P. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

Q. Reducers are generally not shown. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.

R. Lay all underground piping in trenches. Provide and operate pumping equipment to keep trenches free of water.

S. Seal pipes passing through exterior walls with a wall seal per Section 22 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

T. Refer to Section 22 0500 for Excavation, Fill, Backfill and Compaction requirements.

U. Underground Piping Protection:

1. Direct buried, uninsulated steel pipe shall have a factory applied external protective coating consisting of two coats with an intermediate layer of 18 mil fibrous glass mat. Coating thickness shall total not less than 3/32". The outer coating shall be further protected by a wrapping of heavy Kraft paper. This external protection shall extend and be exposed for a minimum of 1 foot beyond the buried or concealed portion of the pipe.
2. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.
3. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
4. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
5. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Architect/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
6. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

V. All vertical pipe drops to equipment installed below the ceiling shall be routed within a wall cavity, unless specifically noted otherwise to be surface mounted. For renovation projects, this Contractor is responsible for opening and patching existing walls for installation of piping. Wall patching shall match existing condition.

W. Install underground plastic pipe with an electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape per section 22 05 53 to facilitate locating. One end of the tracer wire or tape shall be brought aboveground at a building wall or riser.

X. Install corrugated, stainless steel tubing system according to manufacturer's written instructions. Include striker plates to protect tubing from puncture where tubing is restrained and cannot move.

3.05 BONDING AND GROUNDING

A. Each above ground portion of a corrugated stainless steel tubing gas piping systems shall be bonded to the electrical service grounding electrode system. The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first downstream corrugated stainless steel tube fitting. The bonding jumper shall not be smaller than 6 AWG copper wire or equivalent. Gas piping systems that contain one or more segments of corrugated stainless steel tubing shall be bonded in accordance with this section.

B. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.

C. Gas piping shall not be used as a grounding conductor or electrode.

D. Where a lightning protection system is installed, the bonding of the gas piping shall be in accordance with NFPA 780, Standard for the Installation of Lightning Protection Systems.

3.06 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.

B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.

F. Use full and double lengths of pipe wherever possible.

G. Cut all pipe to exact measurement and install without springing or forcing.

H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

I. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Provide and operate sufficient pumping equipment to maintain excavations, trenches and pits free of water. Dispose of pumped water so operation areas and other facilities are not flooded. Pipe laying shall follow excavating as closely as possible.

3.07 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.

B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.

C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

3.08 BRANCH CONNECTIONS

A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.

B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Use of forged weld-on fittings is also limited as follows:

1. Must have at least same pressure rating as the main.
2. Header or main must be 2-1/2" or over.
3. Branch line is at least two pipe sizes under header or main size.

D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

3.09 JOINING OF PIPE

A. Threaded Joints:

1. Ream pipe ends and remove all burrs and chips.
2. Protect plated pipe and valve bodies from wrench marks when making up joints.
3. Apply gas-rated Teflon tape or thread compound to male threads.

B. Flanged Joints:

1. Steel flanges shall be raised face.
2. Bolting for services up to 500°F shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts".
3. Torque bolts in at least three passes, tightening to 1/3, 2/3, and final torque in a cross pattern with an indicating torque wrench for equal tension in all bolts.
4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
    a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
    b. Maximum pressure rating of at least 250 psig.
    c. Minimum temperature rating: -10°F.
    d. Maximum temperature rating of at least 170°F for water systems operating 140°F and less.

C. Welded Joints:

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

D. Fusion Weld:

1. Make all field cuts of pipe square and true using a pipe cutter designed for plastic pipe.
2. Make sure proper heating heads are used for male and female situations.
3. Bevel the leading edge of pipe section with a 45° chamfer.
4. Utilize a fusion welding tool recommended and/or provided by the pipe and fitting manufacturer.

5. Not recommended for temperatures below 40°F.
6. Follow the manufacturer's cold weather installation procedures.
7. All installers shall undergo training provided by the manufacturer or manufacturer's representative.
8. Follow all manufacturers' installation instructions.

3.10 PAINTING EXPOSED PIPE

A. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

3.11 SERVICE CONNECTIONS

A. Provide new gas service complete with gas meter and regulators. Verify gas service pressure with the Utility Company.

END OF SECTION

SECTION 22 1030
PLUMBING SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Cleanouts.
B. Traps.
C. Trap Seals.
D. Floor Drains and Sinks
E. Hub Drains and Standpipes
F. Backflow Preventers.
G. Strainers.
H. Unions.
I. Balancing Valves.
J. Water Hammer Arresters.
K. Dielectric Fittings (Connections Between Dissimilar Metals).
L. Air Vents.
M. Drain Valves.
N. Relief Valves.
O. Compressed Air Filters.
P. Compressed Air Condensate Traps.

1.02 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500.
B. Include sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

2.01 CLEANOUTS

A. Provide cleanouts as shown and specified on the drawings as well as required by code.
B. Coordinate floor cleanout cover with surrounding floor finish. Provide either solid, recessed for tile or terrazzo or carpet marker as applicable.
C. Cleanouts on exposed pipes shall be cast iron with heavy duty cast brass plug with raised head.
D. Cleanout shall be same size as the pipe up to 6" and 6" for larger pipes.

2.02 YARD CLEANOUTS

A. Provide yard cleanouts as shown and specified on the drawings as well as required by code.
B. Cleanout shall be same size as pipe up to 6" and 6" for larger pipes.

2.03 TRAPS

A. Provide all individual connections to the sanitary system with P-traps, except where such drains discharge directly into a properly trapped collection basin or sump. Unless otherwise specified or shown, traps shall be:

1. Chromium plated cast brass when used with plumbing fixtures or when installed exposed in finished spaces.
2. Insulated at accessible lavatories.
3. Cast iron, deep-seal pattern where concealed above ceiling, below grade or in unfinished areas.
4. Deep-seal pattern of the same material and/or coating where drainage lines are of special materials or coatings such as polypropylene, PVDF, CPVC, etc.

B. All traps shall have accessible, removable cleanouts, except where installed on floor drains with removable strainers.

C. Each trap shall be completely filled with water at the end of construction but before building turnover to the Owner. All floor drains, floor sinks, trench drains, etc. shall be filled with water and a 1/2" minimum layer of mineral oil.

2.04 TRAP SEALS

A. Provide trap seals as specified on the drawings.

2.05 FLOOR DRAINS AND SINKS

A. Floor drains and sinks shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.

B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

2.06 HUB DRAINS AND STANDPIPES

A. A hub drain shall be in the form of a hub or pipe without a grate/strainer extending through the floor for receiving indirect waste. A hub drain has a flood level rim above the finished floor.

B. Provide hub drains as shown and specified on the drawings as well as required by code.

2.07 BACKFLOW PREVENTERS

A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.08 STRAINERS

A. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows:

1. Water:
   a. 1/4" - 2": 3/64" perforations
   b. 2-1/2" - 10": 1/16" perforations
   c. 12" - 18": 1/8" perforations

B. Furnish pipe nipple with shutoff valve to blow down all strainer screens.

C. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

2.09 UNIONS

A. Copper pipe - wrought copper fitting - ground joint.

B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.

C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

2.10 BALANCING VALVE WITH FLOW INDICATION

A. Balancing valve with built-in visual flow meter, adjustable flow control with memory stop feature, external temperature gauge, and tight shutoff.

B. Maximum working pressure: 150 psi. Maximum Temperature 230°F. Maximum differential pressure: 15 psi. Maximum inlet temperature: 195°F.

C. Low-lead brass valve, stainless steel springs, EPDM seals.

D. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on the self-contained visual flow meter.

E. Acceptable Manufacturers:

1. Calieffi 132 Series
2. Watts CSD (provide with separate external temperature gauge)

2.11 WATER HAMMER ARRESTERS

A. Provide water hammer arresters as shown and specified on the drawings as well as required by code.

B. ANSI A112.26.1; sized and located in accordance with PDI WH-201, precharged for operation between -100°F and 300°F and maximum 250 psig working pressure.

2.12 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:

1. Iron, steel, and stainless steel connected to each other.
2. Brass, copper, and bronze connected to each other.
3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.

D. Dielectric protection is required at connections to equipment of a material different than the piping.

E. Screwed Joints (acceptable up to 2" size):

1. Dielectric waterway rated for 300 psi CWP and 225°F.
2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.

F. Flanged Joints (any size):

1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

2.13 AIR VENTS

A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.

B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

2.14 DRAIN VALVES

A. Drain valves shall be shutoff valves as specified for the intended service with added 3/4" male hose thread outlet and cap.

2.15 RELIEF VALVES

A. RV-4: (Domestic Hot Water) Pressure and Temperature relief, cast bronze body and internal parts, stainless steel spring, test lever, threaded inlet and outlet. Maximum setting of 150 psi and 210°F temperature. Capacities ASME certified and labeled. Acceptable Manufacturers: Cash Series FV, Watts #40, #120, #N240, #340.

PART 3 - EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Coordinate construction to receive drains at required invert elevations.

B. Install all items per manufacturer's instructions.

C. Water Hammer Arresters:

1. Install water hammer arresters in accessible locations. Provide access doors as required. Coordinate type with Architect/Engineer/Owner.
2. Water hammer arrestors shall be installed in cold and hot water lines upstream of all plumbing fixtures or equipment, with a quick acting valve or multiple quick acting valves. Quick acting valves shall be defined as solenoid actuated valves, manual flush valves, sensor activated faucets and flush valves, squeeze handle spray faucets, and other similar type valves.
3. Install multiple water hammer arrestors in toilet group branch piping greater than 20 feet in developed length from the cold and hot water mains.

D. Cleanouts:

1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet in pipe less than 6" size and 100 feet apart in 6" and larger pipes inside the building. Provide cleanouts at bases of all sanitary and storm risers as shown on the drawings and as required by code.
2. Extend cleanouts to the floor with long sweep elbows.
3. Install a full size, two-way cleanout within 5 feet of the foundation inside or outside of building.
4. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
5. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.

E. Trap Seals:

1. Install trap guard on drains not receiving continuous discharge and subject to drying out.

F. Floor Drains and Floor Sinks:

1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain. Membrane is not required if upper floor construction is single pour, cast-in-place concrete.
2. Use alternate sealing method when installing drains in existing floor slabs.
3. Coordinate sloping requirements with the architectural plans and specifications.
4. Top of floor drain and sinks grate/strainer shall not extend above the finished floor elevation.
5. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised

above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.

G. Hub Drains and Standpipes:

1. The top of a hub drain/standpipe shall extend above the finished floor elevation. Refer to drawings for dimensions above the finished floor.
2. Access shall be provided to drains and standpipes for rodding.

H. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.

I. Balancing Valves:

1. Install balancing valves with straight, unobstructed pipe section both upstream and downstream as required, per manufacturer's installation instructions.

END OF SECTION

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SECTION 22 1200
TANKS - PLUMBING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Domestic Hot Water Storage Tanks.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500. Include manufacturer's installation instructions.

B. For domestic hot water storage tanks, include tank lining instructions.

1.03 REGULATORY REQUIREMENTS

A. Construct pressurized tanks to ASME Code for unfired pressure vessels.

B. Comply with applicable government regulations.

PART 2 - PRODUCTS

2.01 DOMESTIC HOT WATER STORAGE TANKS

A. Tank: Steel, 125 psi working pressure, ASME stamped, with screwed stainless steel connections.

B. Line interior with corrosion resistant concrete approximately 1/2" thick. Line flanged connections. Clean and prime coat before lining. Lining may be factory or field applied. If factory applied, all cracks shall be repaired after installation.

C. Provide 11" x 15" access opening and steel support saddles or legs.

D. Provide tappings for accessories. Include tank drain, water inlet and outlet, 30°F to 200°F thermometer per Section 23 3100, and pressure relief valve suitable for maximum working pressure. Refer to drawings for additional tank openings.

E. Manufacturers:

1. Adamson
2. Ace Boiler
3. Modern Welding
4. RECO
5. PVI
6. Bradford White
7. Cemline.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Support indoor tanks from building structure or construct support stand.

B. Flush and clean tanks prior to delivery to site and keep sealed during construction.

C. Provide all flexible connections required due to tank flex during fill operation.

END OF SECTION

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SECTION 22 1519
COMPRESSED AIR SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Compressed Air Piping (Non-Medical)
B. Condensate Piping
C. Shutoff Valves
D. Automatic Drain Valves
E. Filter
F. Pressure Gauge
G. Flexible Connections
H. Point-of-Use Couplings
I. Compressors
J. Oil-water Separators
K. Lockout Trim
L. Valve Connections

1.02 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

1.03 SUBMITTALS

A. Submit shop drawings per Section 22 0500.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store valves in shipping containers with labeling in place.

1.05 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 22 0500 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

PART 2 - PRODUCTS

2.01 COMPRESSED AIR PIPING (NON-MEDICAL)

A. Design Pressure: 125 psi; Maximum Design Temperature: 150°F
B. Piping - 2" and Under:
   1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
   2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
   3. Fittings: Wrought copper solder joint, ANSI B16.22.

2.02 CONDENSATE PIPING

A. Design Pressure: 125 psi; Maximum Design Temperature: 150°F
B. Piping - 2" and Under:
   1. Tubing: Type DWV hard drawn seamless copper tube, ASTM B306.
   2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
   3. Fittings: Wrought copper solder joint, ANSI B16.22.

2.03 SHUTOFF VALVES

A. Ball Valves:

1. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, vented, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals.
    a. Manufacturers:
        1) Apollo #77C-140
        2) Stockham #S-255-FB-P-UL
        3) Milwaukee #BA-400
        4) Watts
        5) Nibco #585-70-66
        6) National Utilities Co.
        7) RUB
    b. NOTES: Provide lockout trim for all valves.

2.04 AUTOMATIC DRAIN VALVES

A. Zero Loss Drain:

1. Electronic Operation: Electronic level control to monitor liquid level in the drain. Electronic control opens drain valve to discharge condensate and closes before compressed air is lost. 120VAC, alarm mode with visual signal and potential-free contact.
    a. Manufacturers:
        1) Gardner Denver EEDS series
        2) Parker Finite series
        3) Ingersoll-Rand ENL series
        4) Quincy Q-MAT series

2.05 FILTER

A. Particulate: Aluminum or brass body, 125 psi minimum rating, compact modular assembly, NBR seals, metal bowl with poly sight gauge, manual drain, cellulose cartridge filter capable of removing liquids and solids of 5 microns or larger, capacity shall be for rated flow of equipment ASCO Series 65X.

2.06 PRESSURE GAUGE

A. Accuracy Grade 1A (+/- 1% full range), dry for air service, with stainless steel or brass case, non-shatterable safety glass, pressure blowout back, 3-1/2" minimum diameter dial, dial range 0 psi to 200 psi, ASME B40.100 compliant.

1. Manufacturer:
    a. Ashcroft 1009

2.07 FLEXIBLE CONNECTIONS

A. Vibration isolation, wire braid reinforced corrugated metal hose type, line-sized, with bronze end connections, suitable for pressure indicated, length as recommended by manufacturer not less than 18".

B. Hose whip, rubber hose, line size, minimum 250 psi working pressure rating, brass crimped NPT fittings, 36" maximum length.

2.08 POINT-OF-USE COUPLINGS

A. Non-exhausting Type: All brass construction, 1/4" body size, 125 psi minimum working pressure rating, general purpose, manual connect, industrial interchange style, coupling shall have female NPT connection with automatic shutoff, plug shall have male NPT connection.

1. Manufacturers:
    a. Milton, Parker 20 Series
    b. Approved equal

B. Exhausting Type: All brass construction, 1/4" body size, 125 psi minimum working pressure rating, general purpose, push-to-connect, industrial interchange style, coupling shall have female NPT connection with automatic shutoff, plug shall have male NPT connection and ball check to bleed pressure from hose.

1. Manufacturers:
    a. Parker E-z-mate series

2.09 COMPRESSORS

A. Reciprocating:

1. Simplex compressor unit consisting of single-stage, splash lubricated, air-cooled motor driven compressor, integral air receiver, rubber isolators, and operating controls.
2. Compressor Construction:
    a. Construct compressor with cast iron housing and head, heat treated forged steel or ductile iron shaft, aluminum alloy connecting rods, aluminum pistons with rings, and high strength alloy suction and discharge valves. Statically and dynamically balance rotating parts.
    b. Provide oil pressure switch to shut down compressor.
    c. Mount motor and compressor on one-piece ribbed cast iron or welded steel base with provision for V belt adjustment.
    d.
3. Controls: Unit shall be provided with on/off controls.
4. Acceptable Manufacturers:
    a. Curtis
    b. Quincy
    c. Gardner-Denver
    d. Ingersoll Rand

2.10 MOTORS

A. Refer to Section 22 0513, Motors.

2.11 OIL-WATER SEPARATORS

A. Gravity based float system with replaceable filter media.

B. Filter media shall meet or exceed all requirements of state or local waste water discharge regulations.

C. Acceptable Manufacturers:

1. Curtis
2. Quincy
3. Nano
4. JORC
5. Gardner-Denver
6. Ingersoll Rand

2.12 LOCKOUT TRIM

A. Provide lockout trim for all quarter turn shutoff valves.

2.13 VALVE CONNECTIONS

A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install all products per manufacturer's recommendations.

B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

C. Remove scale and dirt on inside and outside before assembly.

D. Connect to equipment with flanges or unions.

3.02 TESTING PIPING

A. Compressed Air Piping, Condensate Piping:

1. Test piping using compressed air per ASME 31.9 requirements.
2. Test piping at 125% of normal operating pressure in accordance with ASME 31.9.
3. Piping shall hold this pressure for one hour with no drop in pressure.

3.03 CLEANING PIPING

A. Assembly:

1. Before assembling pipe systems, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer's representative. Blow chips and burrs from machinery or thread cutting operation out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing.
3. Notify the Architect/Engineer's representative before starting any post erection cleaning in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Dispose of cleaning and flushing fluids properly.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, and be certain all strainer screens are in place.

B. Air Blow:

1. Blow out pipe and components with clean compressed air. Instrument air lines shall be blown out with dry, oil free air or nitrogen gas. "Oil Free" is defined as air compressed in a centrifugal, Teflon ring, carbon ring or water pumped air compressor. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedure may be used until discharge at all blowout points is clean. Use 80-90 psig pressure unless otherwise indicated.

3.04 INSTALLATION

A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

6. Seal pipes passing through exterior walls with a wall seal per Section 22 0529. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

B. Installation Requirements In Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

C. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of each equipment connection without isolating any equipment or portion of the system, unless noted otherwise.
2. Provide clearance for installation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.

3.05 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.

B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.

D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.

E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.

F. Make changes in direction of pipes only with fittings. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.

G. Provide flanges or unions at all final connections to equipment, traps and valves.

H. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.

I. Use full and double lengths of pipe wherever possible.

J. Unless otherwise indicated, install all piping, including shutoff valves, filters, and regulators, to equipment at line size with reduction in size being made only at control valve or equipment.

K. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.

L. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane to prevent carryover of condensate and foreign matter.

3.06 DRAINING AND VENTING

A. Unless otherwise indicated on the drawings, all condensate and compressed air lines, including branches, shall pitch 1" in 40 feet in the direction of airflow to low points for complete drainage, removal of condensate.

B. Maintain accurate grade where pipes pitch or slope for venting and drainage. No pipes shall have pockets due to changes in elevation.

C. Provide drip legs at low points and at the base of all risers in compressed air pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

D. Use eccentric reducing fittings on horizontal runs when changing size of pipes for proper drainage and venting. Install compressed air and gravity drain pipes with bottom of pipe and eccentric reducers in a continuous line; all other liquid lines with top of pipe and eccentric reducers in a continuous line.

E. Provide air vents at high points and wherever else required to eliminate air in all condensate piping systems.

3.07 BRANCH CONNECTIONS

A. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

B. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

C. Forged weld-on fittings are limited as follows:

1. Must have at least same pressure rating as the main.
2. Main must be 2-1/2" or larger.
3. Branch line is at least two pipe sizes under main size.

3.08 JOINING OF PIPE

A. Solder Joints:

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

END OF SECTION

SECTION 22 3000
PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Water Heaters.

B. Water Softeners.

C. Pressure Booster System.

D. Reverse Osmosis System.

1.02 QUALITY ASSURANCE

A. Products and installation of specified products shall conform to recommendations and requirements of the following organizations:

1. American Gas Association (AGA).
2. National Sanitation Foundation (NSF).
3. American Society of Mechanical Engineers (ASME).
4. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
5. National Electrical Manufacturers' Association (NEMA).
6. Underwriters' Laboratories (UL).

B. Water Heater Performance Requirements: Equipment efficiency not less than prescribed by ASHRAE 90.1 when tested in accordance with DOE 10 CFR, ANSI Z21.10.1 and ANSI Z21.10.3.

C. Conform to ASME Section VIII for construction of water heaters and heat exchangers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 0500.

B. Include dimension drawings of water heaters indicating components and connections to other equipment and piping.

C. Include heat exchanger dimensions, size of tappings, and performance data.

D. Include dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.

E. For equipment connected to an electric power source, submit short circuit rating (SCCR) of integrated unit.

F. Submit manufacturer's installation instructions including control and electrical power/controls wiring diagrams.

G. Submit manufacturer's certificate that pressure vessels meet or exceed specified requirements.

H. Submit operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.05 REGULATORY REQUIREMENTS

A. Water heaters shall conform to AGA, ANSI/NFPA 54, ANSI/NFPA 70, ANSI/UL 1453 as applicable.

B. Conform to ANSI/ASME Section 8 Division 1 for fabrication of steel pressure vessels.

C. Conform to ANSI/ASME Section 10 for manufacture of fiber-reinforced plastic pressure vessels.

PART 2 - PRODUCTS

2.01 WATER HEATERS

A. All water heaters shall be as scheduled on the drawings.

2.02 COMMERCIAL WATER SOFTENER

A. Automatic triplex water softener to remove hardness to no more than 1.0 grains per gallon as determined by an ASTM Standard Soap Test Method.

B. Incoming water contains approximately 21 grains per gallon based on information obtained from the local Culligan water sample.

C. System designed for 200,000 grains per 60 lbs. salt minimum and 300,000 grains per 150 lbs. salt maximum exchange capacities. Incoming water contains approximately 21 grains per gallon. Water pressure drop not to exceed 2 psi at continuous flow rate of 50 gpm per softener and 15 psi at a peak flow rate of 152 gpm; 120/1/60 power requirements.

D. Softener Tank(s): Steel, ASME constructed, ASME stamped, designed for a working pressure of 100 psig, hydrostatically tested at 150% of working pressure. Side shell height to allow a minimum freeboard space of 50% of the mineral bed depth for adequate expansion during backwashing. Tank shell of high grade steel. Softener tank not over 30 inches diameter, 60 inches side shell height. Tank shall be internally lined to help prevent corrosion. Tank supported with steel strap legs. Two 4" x 6" elliptical handholes in tanks 30" in diameter or smaller. Exterior primed and painted.

E. Distribution System: Soft water collector and backwash distributor, hub and arm radial or healer lateral type lower distribution system. Distribution shall be covered with a single layer of washed inorganic media to evenly distribute the service and backwash water and support the mineral bed tank.

F. Brine Tank: Rigid polyethylene or fiberglass with tight fitting cover, size not over 30 inches diameter, 50 inches height, corrosion-free elevated salt platform, float-operated plastic fitted brine valve to control brine withdrawal and freshwater refill. The brine valve shall provide positive shutoff to prevent air from entering the system. Brine eductor shall dilute brine flow to softener. Brine shall be provided with a float-operated shutoff valve to keep the tank from overfilling.

1. Provide initial fill of brine tank with manufacturer recommended salt product. Tank shall be full at time the Owner is given occupancy.

G. Softener Ion Exchange Resin: Virgin, high capacity, standard mesh of sulfonated polystyrene type stable over the entire PH range, with good resistance to bead fracture from attrition or osmotic shock. Minimum exchange capacity of 30,000 grains when regenerated with 15 lbs. of salt per cubic foot. Solid resin, of the proper particle size of 20 to 50 mesh, U.S. standard screen, and will contain no agglomerates, shells, plates, or other shapes to interfere with normal function of water softener. The system shall include 10 cubic feet of exchange resin per vessel and a total of 30 cubic feet of resin for the system.

H. Pipes, Valves and Fittings: Pipe shall be galvanized, standard weight steel, Type L copper, or Schedule 5 stainless steel. Fittings shall be 125 lb. Class malleable iron for steel, Type L for copper, and Schedule 5 for stainless steel. All piping shipped assembled shall be hydrostatically tested for leaks at the factory.

I. Water Testing Equipment: Complete with sample cock installed to obtain samples of effluent water. Furnish a complete test kit for conducting soap tests.

J. Automatic Controls:

1. The main control shall be a fully automatic, top-mounted brass control and sized with 3 inch NPT inlet and outlet connections. The top-mounted main control design will be motor driven, mechanically activated, with five pistons to accomplish the regeneration steps of backwash, brine draw/rinse, fast rinse, and brine refill, in addition to the service position.

2. The main control shall incorporate self-adjusting flow regulators to control the rate of flow and prevent resin loss during backwash, regardless of the system pressure fluctuations between 30 and 120 psig.

3. Valves shall be controlled by integral electronic controls. Controls shall display status of each unit with respect to service and regeneration. Controls for multi-tank systems shall be capable of operating units simultaneously, alternating unit service, or progressively bringing additional units on and off line as needed to maintain flow rates and reduce risk of channeling.
4. Regeneration shall be initiated by volume. System shall be programmed so units are unable to regenerate simultaneously.
5. Provide brine reclaim system. During regeneration cycle, a portion of the brine draw/slow rinse cycle waste will be diverted back to the brine tank using specific valve arrangements. Brine reclaim shall be automatically controlled.
6. The unit shall be supplied so that the valve will allow automatic bypass of untreated water during regeneration. The bypass shall be integral to the main control.
7. Each controller shall be provided with dry contacts that will be able to send alarms to the building automation system.
8. Electrical Requirements: Each valve shall be prewired with a plug and cord and an inline breaker to plug into a standard receptacle or wired to a common control panel so a single electrical connection can be provided. 120 volt-single phase. Electric power shall not be needed for manual regeneration. Inlet hydraulic pressure shall be required.

K. Extra Stock:

1. Furnish extra materials as listed below that match products installed and that are packaged and labeled for storage.
    a. Provide one additional gasket for each handhole and manway.

L. Warranty:

1. Provide a standard one-year warranty on the entire unit from the date of final acceptance.
2. Provide a standard two-year warranty on the control valve internal parts, the brine valve and associated parts, and the salt storage container internal components.
3. Provide a standard five-year warranty on the control valve body, fiberglass wound container(s) (if applicable), salt storage container(s) (if applicable), and epoxy lined steel conditioner tank(s) (if applicable).

M. Manufacturers:

1. Culligan
2. Marlo
3. Hellenbrand
4. Diamond
5. Siemens
6. Watts
7. Sterling
8. Avid
9. Water Control

2.03 PRESSURE BOOSTER SYSTEMS

A. Packaged pressure boosting system shall be completely factory assembled, run-tested, and shipped to site as an integral unit assembled on a steel skid including pumps, motors, valves, Type "L" copper suction and discharge manifolds, all interconnecting piping, wiring, variable frequency drives with Logic and power controls. Size and capacity shall be as scheduled on the drawings.

B. Shutoff valves shall be provided on the suction and discharge of each pump. Silent spring- loaded check valves shall be installed on the discharge of each pump.

C. Pressure gauges shall be provided on the front cover of the control panel indicating system suction and discharge pressure. Pressure gauges shall be 4-1/2 inch diameter, Grade 1A, having 1% total range span accuracy and installed with shutoff valve and pressure snubber at gauge connection to system piping. All skid-mounted components shall be factory finished with enamel paint. Individual pumps, motors, variable frequency drives, and check valves shall be serviceable with the booster system in operation, and all components shall be suitable for the maximum system working pressure.

D. System shall include three vertical mounted pumps with ANSI flanged or NPT threaded connections, replaceable casing wear rings, and hydraulically balanced impellers. Pumps shall be cast iron, bronze or stainless steel fitted construction with replaceable shaft sleeves and mechanical seals suitable for 175 psig working pressure.

E. Pressure regulating valves to control system pressure at the unit are not allowed per ASHRAE 90.1.

F. Each pump shall include a pressure relief valve, set to relieve 15 psi above the high limit pressure switch setting, which shall be piped to a floor drain by the installing contractor.

G. Provide a hydro-pneumatic tank with carbon steel or fiberglass shell and a replaceable FDA-approved, heavy-duty bladder to separate the air and water. No water shall come in contact with metal tank walls. Features shall include an air fill valve and bottom system connection suitable for 100% draw-down. Tank shall be constructed in accordance with Section VIII of the ASME code and be N.B. stamped. Refer to schedule on drawings for size. Tank shall be located remote from booster pump. Coordinate location with Architect/Engineer prior to installation.

H. Provide each pump with a premium efficient open drip-proof totally enclosed fan-cooled motor labeled for use with variable frequency drives (VFDs) and sized for operation at any point of the pump curve, including pump run-out (non-overloading operation).

I. Provide and mount on the system skid three VFDs suitable for variable torque applications. Minimum acceptable VFD full load/full speed efficiency shall be 97%, with a fundamental power factor of 0.98. VFDs shall meet the following:

1. Pulse width modulated (PWM).
2. Starts into rotating load.
3. Overcurrent protection.
4. Adjustable carrier switching frequency of up to 8 kHz.
5. Keypad operator device or touchscreen that includes the following:
    a. 2-line backlit display.
    b. Power on and alarm/fault indicators
    c. Hand-Off-Auto switch on VFD front panel cover
    d. When switched to "Auto" operation, the VFDs shall follow the signal from the control panel logic section.
    e. When switched to "Hand", the VFD speed is determined by the setting of the manual speed adjustment located on the VFD front panel cover.
    f. Automatic VFD shutdown for electrical fault
    g. Automatic restart after electrical power is restored from a loss of power
    h. Service diagnostics with fault history log.

J. Provide a high limit pressure switch compatible with the system controls, temperature, and pressure requirements. The pressure switch shall be mounted and wired on the control panel, with sensing line connected to the system discharge manifold. The high limit pressure switch shall shut down the system if the system pressure is more than 30 psi above the normal operating pressure.

K. Provide a pressure sensor/transmitter, shipped loose for field installation, that provides a modulating output compatible with the system controls. The pressure sensor/transmitter shall be used to control booster pump VFDs to maintain a constant system pressure.

L. Provide a factory-mounted pressure sensor/transmitter in the discharge header that provides a modulating output compatible with the system controls. The pressure sensor/transmitter shall be used to control booster pump VFDs to maintain a constant system pressure. Control logic shall be capable of adjusting the pressure setpoint using a system pressure drop algorithm based on real-time flow data.

M. Use of a single pressure sensor/transmitter to control system pressure and high limit pressure cutoff is not acceptable. Both the high limit pressure switch and the pressure sensor/transmitter shall be separately wired back to the booster pump control panel.

N. The lead pump shall run only as necessary to maintain system pressure and will be automatically controlled by means of a pressure sensor/transmitter and control programming to prevent short cycling.

O. If the lead pump is unable to maintain system pressure at the pressure sensor/transmitter, the lag pump will be called on after a time delay and will operate in parallel with the lead pump in accordance with control programming. When a low or no-flow condition is reached, the controls will shut down the lag pump if running and accelerate the lead pump to charge the system and hydro-pneumatic tank to 20 psi above normal operating pressure, then shut the lead pump down and alternate. Should any pump fail to operate, the next pump in sequence shall start automatically.

P. Provide, mount and wire on the skid a programmable logic controller in a NEMA 1 enclosure. The controller shall interface the signals from the sensors to the VFDs and shall provide a stabilized response to speed up or slow down the pump or add additional pumps to meet system requirements. The controller shall provide setpoint control that can be changed by a keypad entry on the control faceplate. The controller shall have an alpha/numeric display, PID functions and both system and controller self-diagnostics. Controller shall be provided with dual function PID loop for startup mode and normal operation. Startup mode shall provide a quick response from shutdown and normal operation is tuned to eliminate hunting. Controller shall have a real-time calendar/clock and memory transfer cartridge.

Q. Provide a UL listed control panel in a NEMA 12 enclosure, factory mounted and wired on the steel skid. The panel shall be furnished with individual pump disconnects with through-the-door handles, pump run lights, H-O-A selector switches, 120-volt fused control transformer, and necessary relays, timers and a programmable controller with pump start, stop and sequence controls.

R. The controller shall be capable of outputting system pressure and a general alarm signal to the building automation system.

S. Non-mercury low pressure control to stop pump operation if incoming water pressure drops to atmospheric.

T. Size and capacity shall be as scheduled on the drawings.

U. Manufacturers:

1. Xylem B&G
2. Grundfos
3. Goulds
4. Metropolitan
5. HYFAB
6. QuantumFlo
7. or approved equivalent

2.04 REVERSE OSMOSIS SYSTEM

A. Complete reverse osmosis system complete with modules, control system and prefilter.

B. The system shall be able to reduce the total dissolved mineral salt content from the water supply. The system shall be capable, upon start up, of reducing the dissolved mineral content of the water by at least 99.01% (nominal rejection), based on membrane industry design standards, when the system is operated in accordance with the operating instructions.

C. The system will be capable of supplying 3342 gallons per day (gpd) of treated water.

D. Influent Water Analysis
   1. Total Hardness - 21 gpg as CaCO3
   2. Total Dissolved Solids, TDS - 410
   3. Iron,0 ppm
   4. 55°F water temperature

E. Design parameters:
   1. Nominal Capacity: 3342 gpd
   2. Approximate Recovery: 50 gpd
   3. Daily water usage: 3342 gpd
   4. Motor, hp: 2
   5. Operating Temperature Range: 33-100°F
   6. Maximum Operating Pressure (Pump): 120-150 psi
   7. Operating Pressure Range (System): 20-50 psi
   8. Inlet Pressure (dynamic): 20-50 psi.
   9. Electrical Requirements: 208-230/60/3
   10. System Dimension: 21 x 31 x 56 inches

F. Effluent Water Quality - Initial effluent water quality based on the analysis is estimated to be 6.64 mg/l TDS

G. Prefilter: The equipment will include one (1) replaceable element type prefilter. Each filter housing will be of polypropylene construction and will contain one (1) prefilter cartridge. Each filter cartridge will be of polypropylene construction and rated at 5 microns nominal to assure maximum protection of the pump and modules.

H. Pump: One pump and motor assembly will be provided to boost the incoming water to an operating pressure of 140.0 psig. Each pump will be close coupled to a 2 HP electrical motor operating at 208-230/60/3.

I. Modules: The unit will use spiral wound reverse osmosis modules. The (2), 4" x 40" (diameter x length) modules will be the polyamide thin film composite membrane type. The module array will be capable, upon initial startup, of producing water at a nominal flow of 3342 gpd based on Culligan equipment specifications as outlined in paragraph 3.2. The module assembly will consist of 2 single element housing(s) in an array arrangement to deliver the design capacity with minimal waste flow requirements. The housings will be constructed of fiberglass (FRP) for corrosion resistance.

J. Pipe and Fittings
   1. The equipment will include all mechanical, hydraulic and electrical controls for a complete, self-contained unit. A 3/4 inch normally closed solenoid valve will be mounted on the inlet to shut off the water supply when the unit is not operating.
   2. Operating Pressure Control Valve: Operating pressure will be controlled by a panel mounted needle-type high pressure control valve connected to the waste line of the modules. It will be constructed of corrosion resistant materials and be equipped with a knob for setting the operating pressure.
   3. Waste Restrictor: A panel mounted combination flow indicator/throttling valve will be connected to the concentrate return to display and maintain the proper recovery ratio of product-to-feed water flow.
   4. Pressure Gauge(s): One liquid filled pressure gauge will be included. The gauge will indicate the operating pressure of the unit over the range of 0 to 400.0 psi.
   5. Flow Indicators: Two inline flow meters will be included to show the rate of product flow and the rate of waste flow which can be viewed on the control panel display.

6. Hydraulic Connections: The system will be designed with a 3/4 NPT connection to the inlet of the prefilter and a 3/4 NPT connection from the prefilter to the feed connection on the unit. The product water connection will be 1/2 NPT. The concentrate water connection will be 1/2 NPT.
7. Mounting: The control assembly, pump assembly, and module assembly are mounted to a rigid 3 to 11 gauge powder coated steel frame and are completely pre-plumbed.

K. Electrical Controls

1. An electronic controller will be utilized to control the logical operation of the unit. A menu driven program operated by a sealed keypad will be used to program the system options. Operational data, such as TDS in/out, percent rejection, feed and product flow, totalized product flow, pumping time and percent recovery, will be displayed on a multi-line OLED display viewable on the front of the enclosure door. Additionally, the controller retains historical operating data which can be used to determine maintenance needs. The display shows messages which indicate if the unit is currently making water, offline, or in a standby mode because of a full storage tank or pre-treatment lock-out condition. If the unit detects that an error has occurred, a short description of the error will display at the push of a keypad button.
2. Connections will be provided to allow easy installation of an optional level control or pressure switch, which will shut down the system and prevent overflow or overpressurizing of an optional product water storage tank. An adjustable pressure sensing switch is installed after the inlet solenoid to protect the pressure pump from cavitation by shutting down the pump and inlet solenoid should the inlet pressure fall below 22.5 psig for more than 3 seconds. An alarm output signal (24VAC, 500mA) is provided for connection to an external alarm.
3. Connections will be provided to allow simplified wiring of an external signal switch, which will shut down the inlet solenoid and pressure pump during the regeneration cycle of pretreatment equipment to prevent untreated water from entering the reverse osmosis system. The system will start automatically when the pretreatment equipment has finished regeneration.
4. The controller includes monitoring of feed and product TDS. The TDS alarm level shall be user adjustable to signal when quality falls below the desired level. A second alarm level allows specification of minimum acceptable rejection percentage.
5. The controller includes monitoring of feed and product flow rates. The flow rates can be used to set high and low alarms based on percentage recovery.
6. The electronic controller shall include a modem device which can be used with an optional telemetry service which allows the unit to record daily operating conditions. The telemetry service also provides for immediate email notification if the system should shut down for any alarm condition.
7. A connection will be provided to allow the use of an external monitoring device using USB, RS232 or RS485 protocols.

L. Field Service: The services of a factory authorized service representative can be made available to supervise, inspect and provide operator training as required for initial start-up and system operation. Contact your local Culligan dealer for service rates and scheduling.

M. Manufacturers:

1. Culligan (G2-2HE),
2. Total Water
3. US Water
4. Water Control
5. Evoqua
6. Chem-Aqua
7. Marcor
8. Marlo Inc.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all items in accordance with manufacturer's instructions.

3.02 WATER HEATER INSTALLATION

A. Install water heaters on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 22 0529.

B. Install water heaters level and plumb, according to drawings, manufacturer's instructions, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

C. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend drain piping full size from relief valve and discharge by positive air gap onto closest floor drain. Discharge pipe material shall be same as domestic water piping.

D. Install gas water heaters according to NFPA 54.

3.03 WATER SOFTENER INSTALLATION

A. Verify connection sizes and piping type with cold water and soft cold water piping. Provide dielectric connection between dissimilar metals. Pressure gauges are required at hard water inlet and soft water outlet of each softener.

B. Provide system start-up and subsequent service, with stocking of spare parts by authorized dealer or factory trained personnel.

C. Provide complete instructions covering installation and operation of the softening system in booklet form. All components shall be easily identified, in exploded views, by individual part number.

D. Provide six hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers shall be included in training.

3.04 PRESSURE BOOSTER INSTALLATION

A. Provide startup by factory authorized start-up technician.

B. Mount pressure sensor/transmitter used to control pressure booster pump VFDs remote from booster pump skid near the most remote critical plumbing fixture as indicated on the drawings, and wire signal directly back to pressure booster control panel. Pressure sensor/transmitter signal shall not interface with or be transmitted across any building information system network. Provide signal amplifiers or repeaters as required to ensure proper control operation.

C. Provide four (4) hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers, shall be included in the training.

D. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger.

E. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.

F. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.

G. Unless otherwise shown on the drawings, mount all pump skids on 4" high concrete pads and anchor frames to pads with cast-in-place anchors.

H. All pump skids shall be grouted in. Follow manufacturer's instructions for grouting.

I. Install on vibration isolators as scheduled on drawings.

J. Coordinate installation to ensure manufacturer's recommended service clearances are met.

3.05 REVERSE OSMOSIS SYSTEM

A. Install reverse osmosis system on concrete bases. Coordinate sizes and locations of concrete bases. Refer to Section 22 0529.

B. Field Service: The services of a factory authorized service representative can be made available to supervise, inspect and provide operator training as required for initial start-up and system operation. Contact your local Culligan dealer for service rates and scheduling.

C. Provide complete instructions covering installation and operation of the reverse osmosis system in booklet form. All components shall be easily identified, in exploded views, by individual part number.

D. Provide four (4) hours of instruction and orientation to the Owner's maintenance staff by factory trained personnel. System walk-through, including programming of any system controllers, shall be included in the training.

END OF SECTION

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SECTION 22 4000
PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. All plumbing fixtures.

1.02 SUBMITTALS

A. Submit product data under provisions of Section 22 0500. Submittals shall include fixture carriers for record purposes only. Architect/Engineer does not review or approve carriers except for manufacturer.

B. Include fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

C. For fixtures and trim requiring electrical connections, submit product data indicating general assembly, components, electrical power/controls wiring diagrams, and service connections.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Wall Hung Fixture Carriers:

1. Material: All Metal, ASME/ANSI A112.6.1M.
2. Manufacturers:
    a. Zurn
    b. Smith
    c. Wade
    d. Josam
    e. Watts
    f. Mifab.
3. Water closet carrier shall be rated to support 500 lbs. unless noted otherwise on the drawings.

B. All fixtures shall be as scheduled on the drawings.

C. All china shall be from the same manufacturer where possible.

D. All lavatory and sink trim shall be from the same manufacturer where possible.

E. All fixtures shall be lead free. Faucets, traps, stops, and other fixture accessories shall not contain more lead than allowed per the latest State or Federal Act.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:

1. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.
2. Install each fixture with trap easily removable for servicing and cleaning. Use screwed tailpiece couplings. Connect fixture waste to stack with slip fitting.
3. Provide fixtures with chrome plated rigid or flexible supplies, loose key stops, reducers, and escutcheons.
4. Install components level and plumb.
5. Caulk joint between finish floor and floor mounted fixtures and between finish walls and wall mounted fixtures with silicon caulk. Caulk the joint, between rim and fixture where a fixture builds into a counter top, with caulking compound. Refer to DIVISION 7 for "Caulking" requirements. Color to match fixture.
6. Where there is a possibility of water following pipe brackets, etc., into a wall; caulk escutcheons, space around brackets, etc., to exclude water. Refer to DIVISION 7 for "Caulking" requirements.

7. Refer to architectural drawings for fixture mounting heights.
8. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.

B. Wall-Mounted Fixture Requirements:

1. All wall-mounted fixtures shall have compatible carriers designed for their intended service and suitable for the space available and configuration of fixtures. All carriers shall extend to the floor and be anchored to the slab.

C. Floor-Mounted Fixture Requirements:

1. Where floor mounted fixtures are installed on a sloped floor, the open void below the fixture shall be grouted, leveled, and caulked to eliminate stress on the fixture and to prevent water migration to the floor below.

D. Exposed or Inside Accessible Cabinets Traps, Valve and Pipe Requirements:

1. All traps exposed under fixtures or inside accessible cabinets shall be chrome plated brass.
2. All water or waste piping for plumbing fixtures that is exposed or inside cabinets shall be chrome plated.
3. All exposed flush valves for water closets and urinals shall have a chrome plated hanger to anchor the piping to the wall.
4. All exposed water supply piping and fittings in a finished space to a shower valve, hose bibb, or other water outlet shall be chrome plated.

E. ADA Accessible Exposed Sink and Lavatory Trim:

1. All exposed sink and lavatory traps, piping and angle stops installed at accessible sink and lavatory locations shall include offset style drain tailpiece, p-trap installed near and parallel with back wall, and insulation kit specially manufactured for this installation. Armaflex with duct tape is not acceptable.

F. ADA Accessible Water Closet Requirements:

1. Handicapped accessible water closet flush valve handles shall face the center of the stall.
2. Coordinate flush valves in handicap accessible locations with grab bars installed by the other Trade Contractors. Make modifications as necessary to flush valve piping to avoid conflict with grab bars. Common solutions include shortened or offset vacuum breaker tailpieces.

3.02 ADJUSTING AND CLEANING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion, clean plumbing fixtures, equipment, and faucet aerator screens.

3.03 FIXTURE ROUGH-IN SCHEDULE

A. Rough-in fixture piping connections in accordance with table on plumbing drawings of minimum sizes for particular fixtures.

END OF SECTION

SECTION 23 0500
BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 23 Sections. Also refer to Division 01 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.

B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.

C. Separate contracts will be awarded for the following work. The division of work listed below is for the contractors' convenience and lists a normal breakdown of the work. Please refer to the bid documents and/or Construction Manager's scope statements for complete scope of work description.

D. Scope of Work:

1. Plumbing Work: Refer to Section 22 0500 "Basic Plumbing Requirements".
2. Heating Work shall include, but is not necessarily limited to:
    a. Extend existing heating water system including pumps, piping, insulation, air control equipment, terminal heating equipment, and specialties. Make final connections to all coils, including those furnished by others.
    b. Furnish and install refrigerant piping, accessories, and final charge of refrigerant.
    c. Furnish and install condensate drain piping from cooling related equipment such as air handlers and cooling coil drain pans.
    d. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work. Refer to 07 8400.
    e. Complete all applicable tests, certifications, forms, and matrices.
3. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:
    a. Furnish and install package indoor air handling units complete with dampers, filters, coils, fans, and motors.
    b. Furnish and install air-cooled condensing units and curbs.
    c. Furnish and install complete supply air ductwork systems including all fittings, insulation, and outlets.
    d. Furnish and install complete return air ductwork systems including all fittings, insulation, and inlets.
    e. Furnish and install all terminal air boxes and reheat coils.
    f. Furnish and install combustion ductwork.
    g. Furnish and install complete exhaust ductwork systems including all fittings, insulation, inlets, and fans.
    h. Furnish and install mechanical room ventilation systems including louvers, ductwork, insulation, and fans.
    i. Furnish and install gas flues, stacks, and breechings.
    j. Furnish and install all temperature control systems.
    k. Complete all applicable tests, certifications, forms, and matrices.
4. Fire Protection Work: Refer to Section 21 0500 "Basic Fire Suppression Requirements".

5. Testing, Adjusting, and Balancing Work shall include, but is not necessarily limited to:
    a. Furnish complete testing, adjusting, and balancing as specified in Section 23 0593, including, but not limited to, air systems, hydronic systems, plumbing systems, and verification of control systems.
    b. Complete all applicable tests, certifications, forms, and matrices

1.03 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. The Owner reserves the right to determine when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 ALTERNATES

A. Bakery Equipment: Rough-ins are part of the Base Bid.

B. Laundry Equipment: Rough-ins are part of Base Bid where noted on the drawings.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
    a. Plumbing Contractor.
    b. Heating Contractor.
    c. Air Conditioning and Ventilating Contractor.
    d. Temperature Control Contractor.
    e. Fire Protection Contractor.
    f. Testing, Adjusting, and Balancing Contractor.
2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.
3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
    a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
    a. Light fixtures.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical busduct.
    d. Sheet metal.
    e. Electrical cable trays, including access space.
    f. Sprinkler piping and other piping.
    g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
    a. Burners.
    b. Condensing Units.
    c. Gas Trains.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.

3. Shall verify all existing equipment sizes and capacities where units are to be modified, moved or replaced. Contractor shall notify Architect/Engineer of any discrepancies prior to ordering new units or replacement parts, including replacements of equipment motors.
4. Temperature Control Subcontractor's Responsibility:
    a. Wiring of all devices needed to make the Temperature Control System functional.
    b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor.
    c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Coordinate with the Mechanical Contractor for size of motors and/or other electrical devices involved with repair or replacement of existing equipment.
5. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
6. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:
1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    a. Scale of drawings:
        1) General plans: 1/4 Inch = 1'-0" (minimum).
        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
        4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
        5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:
1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa's Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.

F. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.

8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
    a. Any item listed as furnished shall also be installed, unless otherwise noted.
    b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:
1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:
1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.
1. Submittals List:

Referenced Specification Section	Submittal Item
23 05 00	Owner Training Agenda
23 05 13	Motors
23 05 29	Hangers and Supports
23 05 29	Prefabricated Curbs
23 05 48	Vibration Isolation Equipment
23 05 53	HVAC Identification
23 05 93	Testing, Adjusting, and Balancing
23 07 13	Duct Insulation
23 07 19	HVAC Pipe Insulation
23 09 00	Controls
23 09 13	Instrumentation
23 23 00	Refrigeration Piping and Specialties

Referenced Specification Section	Submittal Item
23 31 00	Ductwork
23 31 00	Ductwork Layout Drawings
23 31 00	Duct Specialties (such as Turning Vanes)
23 33 00	Duct Silencers
23 34 23	Power Ventilators
23 34 23	Prefabricated Curbs
23 36 00	Terminal Air Boxes
23 37 00	Grilles, Registers, and Diffusers
23 37 00	Louvers
23 40 00	Filters and Filter Systems
23 62 13	Condensing Units
23 73 13	Indoor Modular Air Handling Units
23 82 00	Terminal Heat Transfer Equipment
23 82 16	Coils

B. General Submittal Procedures: In addition to the provisions of Division 01, the following are required:
   1. Transmittal: Each transmittal shall include the following:
      a. Date
      b. Project title and number
      c. Contractor's name and address
      d. Division of work (e.g., plumbing, heating, ventilating, etc.)
      e. Description of items submitted and relevant specification number
      f. Notations of deviations from the contract documents
      g. Other pertinent data
   2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
      a. Date
      b. Project title and number
      c. Architect/Engineer
      d. Contractor and subcontractors' names and addresses
      e. Supplier and manufacturer's names and addresses
      f. Division of work (e.g., plumbing, heating, ventilating, etc.)
      g. Description of item submitted (using project nomenclature) and relevant specification number
      h. Notations of deviations from the contract documents
      i. Other pertinent data
      j. Provide space for Contractor's review stamps
   3. Composition:
      a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions. or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 23 XX XX.description.YYYYMMDD
    b. Transmittal file name: 23 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
1. Condensing Units

B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.

C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.

B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.

C. Coordinate the installation of heavy and large equipment with all Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.14 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the scheduled manufacturer is the basis for job design and establishes the quality required.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections, piping and ductwork connections and arrangement, plumbing connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.

D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.

E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.

F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.16 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 23 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Covering exterior walls, interior partitions and chases.
2. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    a. Pipe insulation is installed and fully sealed.
    b. Pipe and duct wall penetrations are sealed.
    c. Pipe identification and valve tags are installed.
    d. Main, branch and flexible ducts are installed.
    e. Diffusers, registers and grilles are installed and connected to ductwork.
    f. Terminal air box control wiring is complete and all control boxes are closed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.03 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 01.

B. Final Jobsite Observation:

1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

C. Before final payment is authorized, this Contractor must submit the following:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.04 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div23.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, one paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.
2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2" (12mm) thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.
3. Binder Labels: Label the front and spine of each binder with "Operation and Maintenance Instructions", title of project, and subject matter.
4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Refer to Section 23 0900 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.

15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

3.05 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Explanation of all system flow diagrams.
2. Explanation of all air handling systems.
3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
4. Maintenance of equipment.
5. Smoke control systems.
6. Stairwell pressurization systems.
7. Start-up procedures for all major equipment.
8. Explanation of seasonal system changes.
9. Description of emergency system operation.

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

F. Minimum hours of instruction for each item shall be:

1. Refrigeration System - 2 hours.
2. Air Handling System(s) - 4 hours.
3. Exhaust System(s) - 2 hours.
4. Temperature Controls - As defined in Section 23 0900.

G. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

H. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.06 SYSTEM STARTING AND ADJUSTING

A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.

D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.

E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.07 RECORD DOCUMENTS

A. The following paragraphs supplement Division 01 requirements.

B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

D. Refer to Section 23 0900 for additional requirements for Temperature Control documents.

E. Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.

F. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.

G. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

H. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.08 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.

B. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

C. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.

3.09 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.

C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.

D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.

B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Refer to Division 00 and Division 01 specifications for additional requirements which may include special requirements for work within the correctional facility.

3.11 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION

A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, air handling units, fans, terminal air boxes, fan coil units, cabinet heaters, blower coils, and the like.

B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.

C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.

D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.

E. The following steps shall be taken during testing, adjusting, and balancing of each air system:

1. All construction activities in all spaces served by the air system shall stop.
2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.
3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.
4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.

F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. All air handling units operating and balanced.
2. All fans shall be operating and balanced.
3. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
4. All temperature control systems operating, programmed and calibrated.
5. Pipe insulation complete, pipes labeled, and valves tagged.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

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SECTION 23 0505
HVAC DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Mechanical demolition.

B. Cutting and Patching.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.

B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.

C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.

D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.

E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.

F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.

G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

3.02 PREPARATION

A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.

B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.

C. Existing Heating System: Maintain existing system in service until new system is complete and ready for service. Drain system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before partially or completely draining system. Minimize outage duration.

3.03 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned ducts and piping to source of supply and/or main lines.

D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.

E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.

F. Repair adjacent construction and finishes damaged during demolition and extension work.

G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.

H. Remove unused sections of supply and return air ductwork back to mains. Patch opening with sheet metal and seal airtight. Patch existing insulation to match existing. Where existing ductwork is to be capped and reused, locate the end cap within 6" of the last branch. End caps shall be 3" pressure class and seal class "A".

I. Extend existing installations using materials and methods compatible with existing installations, or as specified.

3.04 CUTTING AND PATCHING

A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 23 0529 for additional requirements.

B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.

D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.

E. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means.

F. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.05 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.

C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

3.06 SPECIAL REQUIREMENTS

A. Install temporary filter media over outside air intakes which are within 100 feet of the limits of construction. This Contractor shall complete any cleaning required for existing systems which are affected by construction dust and debris.

B. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION

SECTION 23 0513
MOTORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single Phase and Three Phase Electric Motors.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.

B. Submit shop drawings for all three phase motors.

C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.

D. Submit shaft grounding rings or brushes or ceramic bearings for all motors as required.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories.

PART 2 - PRODUCTS

2.01 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. Design motors for continuous operation in 40ºC environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.

D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.

E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.

F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.

G. Each contractor shall set all motors furnished by him.

H. All motors shall have a minimum service factor of 1.15.

I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.

J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.

K. Aluminum end housings are not permitted on motors 15 HP or larger.

L. Motor Driven Equipment:

1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.

2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.

M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Slide bases shall conform to NEMA standards.

N. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

2.02 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

A. All motors, unless exempted by EPAct legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
HP	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0
20.0	92.4	93.0	91.0	91.7	93.0	91.0

B. Motor nameplate shall be noted with the above ratings.

2.03 MOTORS ON VARIABLE FREQUENCY DRIVES

A. All motors driven by VFDs shall be premium efficiency type.

B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.

C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.

D. All 480 volt motors driven by VFDs shall be provided with shaft grounding rings or grounding brushes or ceramic bearings as a means to protect bearings from adverse shaft currents.

1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.

2. Motor shafts 2" and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.

2.04 SHEAVES

A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.

B. When replacing sheaves, use sheaves of at least the originally supplied sizes.

C. Contractor responsible for motor shall also be responsible for replacement sheaves. Coordinate with testing and balancing of the equipment.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust, if necessary, during the first day of operation and again after 80 hours of operation.

END OF SECTION

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SECTION 23 0529
HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Hangers, Supports, and Associated Anchors.

B. Equipment Bases and Supports.

C. Sleeves and Seals.

D. Flashing and Sealing of Equipment and Pipe Stacks.

E. Cutting of Openings.

F. Escutcheon Plates and Trim.

1.02 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 0500. Include plastic pipe manufacturers' support spacing requirements.

1.03 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

A. Furnish sleeves and hanger inserts to Division 3 Contractor for placement into formwork.

PART 2 - PRODUCTS

2.01 HANGER RODS

A. Hanger rods for single rod hangers shall conform to the following:

	Hanger Rod Diameter	
Pipe Size	Column #1	Column #2
2-1/2" and smaller	3/8"	3/8"
3" through 3-5/8"	3/8"	3/8"
4" and 5"	1/2"	1/2"
6"	3/4"	5/8"

Column #1: Steel pipe.

Column #2: Copper pipe.

B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.

C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.02 PIPE AND STRUCTURAL SUPPORTS

A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).

2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate

expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.

a. Products:

1) Cooper/B-Line Fig B3373 Series

2) Erico 510 Series

3) Nibco/Tolco Fig. 82

2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.

a. Products:

1) Mason RBA, RCA or RDA

2) Mason BR

3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.

a. Products:

1) Pipeshields E100

4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.

5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.

2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.

3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.

4. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

a. Products:

1) Anvil Fig. 160, 161, 162, 163, 164, 165

2) Cooper/B-Line Fig. 3160, 3161, 3162, 3163, 3164, 3165

3) Erico Model 630, 631, 632, 633, 634, 635

4) Nibco/Tolco Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4

5. Unless otherwise indicated, hangers shall be as follows:

a. Clevis Type: Service: Bare Metal Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and Smaller:

1) Products: Bare Steel, Plastic or Insulated Pipe:

a) Anvil Fig. 260

b) Cooper/B-Line Fig. 3100

c) Erico Model 400
d) Nibco/Tolco Fig. 1

2) Products: Bare Copper Pipe:
a) Cooper/B-Line Fig. B3100C
b) Nibco/Tolco Fig. 81PVC

b. Continuous Channel with Clevis Type: Service: Soft Copper Tubing:
1) Products:
a) Cooper/B-Line Fig. B3106, with Fig. B3106V
b) Erico Model 104, with Model 104V
c) Nibco/Tolco Fig. 1V

c. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller:
1) Products: Bare Steel Pipe:
a) Anvil Fig. 69
b) Cooper/B-Line Fig. B3170NF
c) Erico Model FCN
d) Nibco/Tolco Fig. 200.

2) Products: Bare Copper Pipe:
a) Cooper/B-Line Fig. B3170CTC
b) Erico 102A0 Series
c) Nibco/Tolco Fig. 203

6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.

7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
a. Clamp Type: Service: Bare Metal Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller:
1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
3) Products: Bare Steel or Insulated Pipe:
a) Unistrut Fig. P1100 or P2500
b) Cooper/B-Line Fig. B2000 or B2400
c) Nibco/Tolco Fig. A-14 or 2STR

4) Products: Bare Copper Pipe:
a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):

1) Products:

a) Anvil Fig. 92

b) Cooper/B-Line Fig. B3033/B3034

c) Erico Model 300

d) Nibco/Tolco 68

b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):

1) Products:

a) Anvil Fig. 228, 292

b) Cooper/B-Line Fig. B3054

c) Erico Model 360

d) Nibco/Tolco Fig. 329

c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):

1) Products:

a) MCL. M1, M2 or M3

d. Concrete: Inserts Single Rod Galvanized:

1) Products:

a) Anvil Fig. 282

b) Cooper/B-Line Fig. B3014

c) Erico Model 355

d) Nibco/Tolco Fig. 310

e. Concrete: Inserts Continuous Strip Galvanized:

1) Products:

a) Unistrut Corp P3200 Series

b) Cooper/B-Line Fig. B22-J

c) Erico CONCT

f. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

g. Steel Structure Welding:

1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

2.03 FOUNDATIONS, BASES, AND SUPPORTS

A. Basic Requirements:

1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.

2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

B. Concrete Bases (Housekeeping Pads):

1. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
2. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
3. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days (be 20 MPa strength).
4. Equipment requiring bases is as follows:
   a. Air Handling Unit

C. Supports:

1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

2.04 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the Division 3 Contractor for installation or construction as the structure is built.

B. Coordinate all openings with other Contractors.

C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.

D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.

E. Do not cut structural members without written approval of the Architect or Structural Engineer.

F. Exposed Housing Penetrations: Seal pipes with surface temperature below 150°F, penetrating housings with conical stepped, white silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite.

2.05 ROOF PENETRATIONS

A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for duct penetrations. Refer to drawings for details.

B. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: Black shall match roofing material.

C. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

2.06 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.

B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.

C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.

D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas.

E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.

F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

G. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

2.07 ESCUTCHEON PLATES AND TRIM

A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.

B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.

C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

2.08 PIPE PENETRATIONS

A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.

B. Seal fire rated wall and floor penetrations with fire seal system as specified.

2.09 PIPE ANCHORS

A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.

B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

2.10 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

PART 3 - EXECUTION

3.01 HVAC SUPPORTS AND ANCHORS

A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Set all concrete inserts in place before pouring concrete.
3. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
4. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
5. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

C. Pipe Requirements:

1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.
2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
4. Piping shall not introduce strains or distortion to connected equipment.
5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    a. The hanger is attached within 6" from a web/chord joint.
    b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.

H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

1. Steel (Std. Weight or Heavier - Liquid Service):
    a. Maximum Spacing:
        1) 1-1/4" & under: 7'-0"
        2) 1-1/2": 9'-0"
        3) 2": 10'-0"
        4) 2-1/2": 11'-0"
        5) 3": 12'-0"
        6) 4" & larger: 12'-0"
2. Steel (Std. Weight or Heavier - Vapor Service):
    a. Maximum Spacing:
        1) 1-1/4" and under: 9'-0"
        2) 1-1/2": 12'-0"
        3) 2" & larger: 12'-0"
3. Hard Drawn Copper & Brass (Liquid Service):
    a. Maximum Spacing:
        1) 3/4" and under: 5'-0"
        2) 1": 6'-0"
        3) 1-1/4": 7'-0"
        4) 1-1/2" 8'-0"
        5) 2": 8'-0"
        6) 2-1/2": 9'-0"
        7) 3": 10'-0"
        8) 4": 12'-0"
        9) 6": 12'-0"
4. Hard Drawn Copper & Brass (Vapor Service):
    a. Maximum Spacing:
        1) 3/4" & under: 7'-0"
        2) 1": 8'-0"
        3) 1-1/4": 9'-0"
        4) 1-1/2": 10'-0"
        5) 2": 11'-0"
        6) 2-1/2" & larger: 12'-0"
5. Soft Copper Tubing:
    a. Continuous channel with hangers maximum 8'-0" OC.

I. Installation of hangers shall conform to MSS SP-58, -69, and -89.

END OF SECTION

SECTION 23 0530
ROOF SUPPORT AND WIND BRACING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wind Restraint of Rooftop Equipment

B. Rooftop Pipe Support

C. Rooftop Equipment Support

1.02 QUALITY ASSURANCE

A. General:

1. The Contractor shall retain a specialty consultant or equipment manufacturer to develop a wind restraint and support system and perform wind restraint calculations in accordance with these specifications, state, and local codes.
2. These requirements are beyond those listed in Section 23 0550 of these specifications. Where a conflict arises between the wind restraint of this section and any other section, the Architect/Engineer shall be immediately notified for direction to proceed.

B. Manufacturer:

1. System Supports/Restraints: Company specializing in the manufacture of products specified in this section.
2. Equipment: Each company providing equipment that must meet wind restraint requirements shall provide certification included in project submittals that the equipment supplied for the project meets or exceeds the wind restraint of the project.

C. Installer: Installed by Contractor.

1.03 REFERENCES

A. International Building Code 2015

B. Technical Manual 5-809-10, NAVFAC P-355, Air Force Manual 88-3, Chapter 13

C. ASCE 7-10, Chapter 29

1.04 SUBMITTALS

A. Submit under provisions of Section 23 0500.

B. Shop Drawings:

1. Coordination Drawings: Plans and sections drawn to scale, coordinating wind restraint bracing of mechanical components with other systems and equipment in the vicinity, including other wind restraint restraints.
2. Manufacturer's Certifications: Professional Engineer licensed in the state where the project is located shall review and approve manufacturer's certifications of compliance.
3. System Supports/Restraints - Submit for each condition requiring wind restraint bracing:
    a. Calculations for each wind restraint brace and detail used on the project.
    b. Plan drawings showing locations and types of wind restraint braces on contractor fabrication/installation drawings.
    c. Cross-reference between details and plan drawings to indicate exactly which brace is being installed at each location. Details provided are to clearly indicate attachments to structure, correctly representing the fastening requirements of bracing.
    d. Clear indication of brace design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

4. Equipment - Submit for each piece of equipment supplied:
    a. Certification that the equipment supplied for the project meets or exceeds the wind restraint requirements specified.
    b. Specific details of wind restraint design features of equipment and maximum wind restraint loads imparted to the structural support.
    c. Engineering calculations and details for equipment anchorage and support structure.

C. A wind restraint designer shall be provided whether or not exceptions listed in the applicable building code are met. If wind restraint restraints are not provided for a system that requires wind restraint bracing, the wind restraint designer shall submit a signed and sealed letter to the Architect/Engineer and Authorities Having Jurisdiction stating the exceptions, along with code reference, used for each item. Wind restraint designer shall review system installation for general conformance to the exception requirements stated in the code and document, in writing, the system has been installed in accordance with the exception.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site. Accept material on site in factory containers and packing. Inspect for damage. Protect from damage and contamination by maintaining factory packaging until installation. Follow manufacturer's instructions for storage.

1.06 DESIGN REQUIREMENTS

A. This project is subject to the wind loading requirements of the International Building Code 2015 edition.

B. The total height of the structure and the height of the system to be restrained within the structure shall be determined in coordination with architectural plans and the General Contractor.

1.07 COORDINATION

A. Coordinate layout and installation of anchoring with building structural systems and architectural features, and with mechanical, fire-protection, electrical and other building features in the vicinity.

1.08 WARRANTY

A. Provide one-year warranty on parts and labor for manufacturer defects and installation workmanship.

PART 2 - PRODUCTS

2.01 SUPPLIERS

A. Miro Industries

B. Engineer pre-approved equal

2.02 DESIGN CRITERIA

A. The following design criteria applies to all equipment noted below.

B. General Information:
    1. Adopted Building Code: IBC2015
    2. Building Occupancy Risk Category: III

C. Wind Design Criteria:
    1. Mean Roof Height: 17.5 feet
    2. Basic Wind Speed: 120 MPH @ 3-second gust
    3. Exposure Category: C

2.03 ROOF PIPING SUPPORTS

A. Non-Penetrating Pillow Block Supports:
    1. Provide pre-fabricated non-penetrating pillow block roof pipe supports for all piping installed on the roof.
    2. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.

3. Acceptable Products:
    a. Anvil International HBS-Base Series
    b. Cooper B-Line Dura-Blok
    c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load)
    d. Miro Industries 1.5, 3-R, 4-R or 5-R (to match pipe)

B. Premanufactured Anchored Roof Pipe Supports:
1. Roof duct support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop piping system for uplift and lateral loading.
2. Refer to drawings for pipe size, layout, structural framing, roofing material, and wind loading information.
3. Provide adjustable pre-fabricated pipe supports for all pipe installed on the roof. Supports include a combination of non-penetrating pillow block pipe supports and stanchioned supports anchored to the roof structure.
    a. Supports shall be constructed from hot dipped galvanized steel minimum 12-gauge channel or tube steel. Manufacturer shall determine final design.
4. Pillow block base shall be UV resistant polycarbonate rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
5. Acceptable Manufacturer:
    a. Miro Industries DS and Stanchioned DS

2.04 ROOF EQUIPMENT SUPPORTS

A. Equipment Roof Curbs and Rails:
1. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.
2. Refer to drawings for equipment size, layout, structural framing, roofing material, and wind speed.
3. Provide adjustable prefabricated roof equipment supports for all equipment installed on the roof. Supports include stanchioned supports anchored to the roof structure.
4. Equipment requiring curbs or rails with this section is as follows:
    a. Condensing units
    b.
5. Provide prefabricated curbs or rails as follows:
    a. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
    b. 14 or 18 gauge galvanized sheet metal, as required for the equipment weight.
    c. Internal reinforcing.
    d. Pressure treated wood nailer.
    e. 18 gauge counter flashing completely covering nailer.
    f. Factory insulated with rigid fiberglass.
6. Refer to drawings for curb and rail heights.
7. Match units to the building roof with either a raised cant to match roof insulation (for built-up roofs) or with no cant (for single-ply roofs).
8. Where legs of equipment rest on rails, provide 1/4" bent plates 18" long.
9. Manufacturers:
    a. Thy
    b. Pate

c. United
d. Roof Products Systems
e. Portals Plus

B. Exhaust Fans, Roof Hoods, Etc.:
1. Curb provided with equipment. Rooftop equipment such as roof hoods and rooftop exhaust fans shall be provided with curbs by the unit manufacturer. Refer to individual equipment sections for curb description.
2. This section shall provide anchoring such as guy wires, tethers, or straps to limit wind disruption.
3. Roof equipment support manufacturer shall provide ASCE-7 code-compliant sealed submittal to support and restrain rooftop equipment for uplift and lateral loading.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all items per manufacturer's instructions.
B. All wind restraint systems shall be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
C. Installation of wind restraints shall not cause any change in position of equipment, piping, or ductwork resulting in stresses or misalignment.
D. Prior to installation, bring to the Architect/Engineer's attention any discrepancies between the specifications and the field conditions, or changes required due to specific equipment selection.
E. Bracing may occur from flanges of structural beams, upper truss cords of bar joists, cast-in-place inserts.
F. Cable restraints shall be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit. Cable assemblies shall be installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only. Do not install cables over sharp corners.
G. Provide reinforced clevis bolts when required.
H. The vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not acceptable.
I. Positively attach all roof-mounted equipment to roof curbs. Positively attach all roof curbs to building structure.
J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
K. Supports shall extend directly to building structure.
L. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the drawings as being by others.
M. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
N. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.

3.02 ROOF PIPING SUPPORTS

A. Roof Supports: Install per manufacturer's requirements. Coordinate with Roofing Contractor.
B. Install roof pipe supports to resist wind movement per manufacturer's recommendations. Method of securing base to roof shall be compatible with roofing materials.
C. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.
D. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories, to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

E. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

F. Support piping at equipment and valves so it can be disconnected and removed without further supporting the piping.

G. Piping shall not introduce strains or distortion to connected equipment.

H. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, and at equipment connections and heavy fittings.

I. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

J. Spacing: Refer to Supports and Anchors section for pipe spacing requirements.

3.03 INSPECTION

A. Special inspection and testing shall be done in accordance with Chapter 17 of the International Building Code.

B. The Contractor shall employ a Special Inspection Agency to perform the duties and responsibilities specified in Section 1704 and 1705.

C. Work performed on the premises of a fabricator approved by the building official need not be tested and inspected. The fabricator shall submit a certificate of compliance that the work has been performed in accordance with the approved plans and specifications to the building official and the Architect and Engineer of Record.

D. The Special Inspection Agency shall furnish inspection reports to the building official, the Owner, the Architect, and the Engineer of Record. The reports shall be completed and furnished within 48 hours of inspected work. A final signed report stating whether the work requiring special inspection was, to the best of the Special Inspection Agency's knowledge, in conformance with the approved plans and specifications shall be submitted.

END OF SECTION

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SECTION 23 0548
HVAC VIBRATION ISOLATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Bases.

B. Vibration Isolation.

C. Flexible Connectors.

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500 and the Vibration Isolation Submittal Form at the end of this section.

B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.

C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.

D. Isolator submittals shall include:

1. Equipment served
2. Type of Isolator
3. Load in Pounds per Isolator
4. Recommended Maximum Load for Isolator
5. Spring Constants of Isolators (for Spring Isolators)
6. Load vs. Deflection Curves (for Neoprene Isolators)
7. Specified Deflection
8. Deflection to Solid (at least 150% of calculated deflection)
9. Loaded (Operating) Deflection
10. Free Height
11. Loaded Height
12. Kx/Ky (horizontal to vertical stiffness ratio - for spring isolators)
13. Materials and Coatings
14. Spring Diameters

E. Make separate calculations for each isolator on equipment where the load is not equally distributed.

F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

PART 2 - PRODUCTS

2.01 BASIC CONSTRUCTION AND REQUIREMENT

A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.

C. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

E. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

F. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.

G. Provide motor slide rails for belt-driven equipment per Section 23 0513.

H. All isolators shall have provision for leveling.

2.02 MOUNTINGS

A. Type M2:

1. Double deflection neoprene with minimum static deflection of 0.15" at calculated load and 0.35" at maximum rated load.
    a. All metal shall be neoprene covered. Mounting shall have friction pads both top and bottom.
2. All units shall have bolt holes and be bolted down.
3. Use steel rails above the mountings to compensate for the overhang of equipment such as small vent sets and close coupled pumps.
4. Manufacturers:
    a. Mason Industries "ND" or "DNR"
    b. Amber/Booth "RVD"
    c. Kinetics "RD"
    d. Vibration Mountings and Controls "RD"
    e. Vibration Eliminator Co. "T22" or "T44"

B. Type M4:

1. Use restrained spring mountings for equipment with operating weight different from the installed weight such as chillers and boilers, and equipment exposed to the wind such as cooling towers.
2. Spring isolators shall be free-standing with 1/4" neoprene acoustical friction pads.
3. All units shall have bolt holes and be bolted down. Prevent short circuiting with neoprene bushings and washers between bolts and isolators.
4. All mountings shall have leveling bolts.
5. Housings with vertical resilient limit stops shall prevent spring extension when weight is removed. Housings shall serve as blocking during erection and the installed and operating heights shall be the same.
6. Maintain a minimum clearance of 1/2" around restraining bolts and between the housings and the springs so as not to interfere with the spring action.
7. Limit stops shall be out of contact during normal operation.
8. Select isolators for equipment subjected to wind loads in conformance with ASCE 7-02.
9. Manufacturers:
    a. Mason "SLRS"
    b. Kinetics "FLS"
    c. Aeroflex "AWRS"
    d. Vibration Eliminator Co. "KW"

2.03 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.
4. Manufacturers:
    a. Mason "HD"
    b. Kinetics "RH"
    c. Aeroflex "RHD"
    d. Vibration Eliminator Co. "IC/3C/3CTD"
    e. Vibro Acoustics "RH"

B. Type H3:

1. Vibration hangers shall have a steel spring in a neoprene cup with a grommet to prevent short circuiting of the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Hangers shall be capable of holding the load at a fixed elevation during installation. They shall have a secondary adjustment to transfer the load to the spring and maintain the same position.
6. Deflection shall be indicated by a pointer and scale.
7. Manufacturer:
    a. Mason "30N"
    b. Kinetics "SFH"
    c. Amber/Booth "BSW"
    d. Vibration Eliminator Co. "SNRC"
    e. Vibro Acoustics "SHR"

2.04 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

A. Type FC1:

1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.
2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.
3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.
4. Connectors up to 2" size may have threaded ends.
5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.
6. All connectors shall be rated for a minimum working pressure of 150 psi at 200°F.
7. Manufacturer:
    a. Metraflex "Double Cable-Sphere"
    b. Minnesota Flex Corp.

c. Mercer "200 Series"
d. Twin City Hose "MS2".

B. Type FC2:
1. Stainless steel flexible connectors with corrugated stainless steel hose body and stainless steel braided casing.
2. Rated for minimum working pressures of 150 psi at 70°F and 100 psi at 800°F.
3. Sizes 2" and under shall have steel threaded connections.
4. Sizes 2-1/2" and over shall have 150 lb. steel flanges.
5. Suitable for 1/2" permanent misalignment.
6. Manufacturers:
a. Mason or Mercer "BSS-GU"
b. Metraflex "ML"
c. Twin City Hose "TCHS"
d. American "BOA B4-1"
e. Flexible Metal Hose Company "FM-21"
f. or Wheatley.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.

F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

3.02 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. Where piping is floor-supported, use M2 instead of H1.

C. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.

D. Use Type FC1 where pressures are lower than 150 psi, temperatures are below 220°F, and the fluid handled is compatible with neoprene and EPDM.

E. Use Type FC2 for all other services. FC2 shall be installed parallel with equipment shafts.

F. Provide sufficient piping flexibility for vibrating refrigerant equipment or furnish flexible connectors with appropriate temperature and pressure ratings.

G. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.

H. Support piping to prevent extension of flexible connectors.

3.03 VIBRATION ISOLATION OF DUCTWORK

A. The first three hangers on all fan systems shall be Type H1 with at least 0.20" minimum static deflection.

B. Provide flexible duct connections as described in Section 23 3300 at all fan inlets and outlets and on the mechanical room side of all locations where ducts penetrate mechanical room walls.

END OF SECTION

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VIBRATION ISOLATION SUBMITTAL FORM

COLUMN 1	2	3	4	5	6	7	8	9	10	11	12
		PROPOSED ISOLATOR							CALCULATIONS		
ITEM SERVED	MIN DEFL (")	TAG	MODEL	MAX LOAD (#)	DEFL @ MAX LOAD (")	DEFL TO SOLID (")	FREE HT (")	Kx/Ky	LOAD (#)	DEFL (")	DEFL RATIO

COLUMN NOTES: Note numbers correspond to the column numbers above.

1. Item served should match designation on the design drawings.
2. List the deflection scheduled or specified in the design documents.
3. List the designation for this isolator. This is most useful when one item has multiple different isolators to support its weight.
4. List the manufacturer's complete model designation for the isolator.
5. List the manufacturer's maximum rated load for the isolator.
6. List the isolator deflection at the maximum rated load in column 5.
7. For spring isolators list the deflection when the springs are solid. This is not normally the same entry as in column 6.
8. List the height of the isolator when unloaded. Shop drawings must show where this is measured.
9. List the rated horizontal to vertical stiffness ratio. This must be between 0.8 and 2.0.
10. List the calculated equipment load on each isolator. For items with unequal weight distribution, calculate each isolator separately.
11. List the calculated deflection under the calculated load. For springs this will be column 10*(column 6 / column 5).
12. List the answer from dividing column 7 by column 11. This must be at least 1.5. If not, select an isolator with more nominal deflection.

GENERAL NOTES:

1. When submitting hangers or supports for a weight range, fill in two rows - one for the maximum and one for the minimum weight.

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SECTION 23 0553
HVAC IDENTIFICATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Identification of products installed under Division 23.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500. Include list of items identified, wording, letter sizes, and color coding.

B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. 3M

B. Bunting

C. Calpico

D. Craftmark

E. Emedco

F. Kolbi Industries

G. Seton

H. W. H. Brady

I. Marking Services.

2.02 MATERIALS

A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4" (32mm)	8" (200 mm)	1/2" (12 mm)
1-1/2" (40 mm) to 2" (50 mm)	8" (200 mm)	3/4" (20 mm)
2-1/2" (65 mm) to 6" (150 mm)	12" (300 mm)	1-1/4" (32 mm)
8" (200 mm) to 10" (250 mm)	24" (600 mm)	2-1/2" (65 mm)
Over 10" (250 mm)	32" (800 mm)	3-1/2" (90 mm)

Plastic tags may be used for outside diameters under 3/4" (20 mm)

B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.

C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

E. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2" square or 1-1/2" round.

F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

G. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

H. Stencil Painted Pipe Markers: Use industrial enamel spray paint per ANSI Standard A13.1. Indicate fluid conveyed and flow direction.

I. Ceiling Markers:

1. Label Style:

a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves. An arrow can be used to point to the tile needing removal.

b. The label tape shall be approximately 1/2" wide with all capitalized letters approximately 3/16” tall.

c. Ceiling grid labels shall be made with a label maker with durable adhesive labels having a clear background and black letters.

d. Equipment labels shall be as designated on the drawings (e.g., FCU-606B, etc.).

e. Valve labels shall be designated by the size, service, and the valve tag number (e.g., 1-1/4” CW #123, 2” HWS #234, etc.). A single longer label can be used to identify multiple valves using spaces between the descriptors if the valves are located close together and have the same service (e.g., HWS and HWR valves serving the same equipment or CW, HW, and HWC lines serving the same restroom, etc.).

2. "Dot " Style:

a. The intent is for the ceiling labels to be inconspicuous but easy to find and read while standing underneath. The labels shall be located on the grid T-bar nearest the ceiling tile that can be removed to provide the best access to the serviceable side of equipment or to valves.

b. The marker shall be a self-adhesive color dot approximately 1/2” in diameter.

c. The equipment and accessories to be marked and dot color shall be coordinated with the Architect/Engineer and Owner.

1) Equipment and accessories to be marked:

a) Hydronic Valves

b) Project Specific Item

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all products per manufacturer's recommendations.

B. Degrease and clean surfaces to receive adhesive for identification materials.

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.

2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.

3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.

4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.

5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.

6. Number all tags and show the service of the pipe.

7. Provide two sets of laminated 8-1/2" x 11" (letter size) copies of a valve directory listing all valves, with respective tag numbers, uses, and locations. The directory shall be reviewed by the Owner and Architect/Engineer prior to laminating final copies. Laminated copies shall have brass eyelet in at least one corner for easy hanging.

D. Pipe Markers:

1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Stencil Painted Pipe Markers:
    a. Remove rust, grease, dirt, and all foreign substances from the pipe surface.
    b. Apply primer on non-insulated pipes before painting.
    c. Use background and letter colors as scheduled later in this section.
4. Apply markers and arrows in the following locations where clearly visible:
    a. At each valve.
    b. On both sides of walls that pipes penetrate.
    c. At least every 20 feet along all pipes.
    d. On each riser and each leg of each "T" joint.
    e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.02 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. HEATING WATER SUPPLY: White lettering; green background
2. HEATING WATER RETURN: White lettering; green background
3. CONDENSATE DRAIN: White lettering; green background
4. REFRIGERANT LIQUID: White lettering; purple background
5. REFRIGERANT SUCTION: White lettering; purple background
6. REFRIGERANT HOT GAS: White lettering; purple background

END OF SECTION

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Testing, adjusting, and balancing of air systems.

B. Testing, adjusting, and balancing of heating systems.

C. Testing, adjusting, and balancing of cooling systems.

D. Testing, adjusting, and balancing of plumbing systems.

E. Measurement of final operating condition of HVAC systems.

1.02 QUALITY ASSURANCE

A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section . Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.

B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

1.03 REFERENCES

A. AABC - National Standards for Total System Balance, Seventh Edition.

B. ADC - Test Code for Grilles, Registers, and Diffusers.

C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.

D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.

E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.

F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.

G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.

H. TABB - International Standards for Environmental Systems Balance.

1.04 SUBMITTALS

A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Electronic Copies:

1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.

3. All text shall be searchable.

4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

C. Paper Copies:

1. Submit four (4) certified copies of test reports to the Architect/Engineer for approval in soft cover, 3-hole binder manuals, with cover identification. Include index page and indexing tabs.

1.05 REPORT FORMS

A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.

B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.

C. Refer to PART 4 for required reports.

1.06 WARRANTY/GUARANTEE

A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.

B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.07 SCHEDULING

A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.

B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.

C. Recorded data shall represent actual measured or observed conditions.

D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.

E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.

F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.

G. The Balancing Contractor shall measure terminal air box air flow, and the TCC shall adjust DDC readout to match. Refer to Section 23 0900 for additional information.

H. Installations with systems consisting of multiple components shall be balanced with all system components operating.

3.02 EXAMINATION

A. Before beginning work, verify that systems are complete and operable. Ensure the following:

1. General Equipment Requirements:
    a. Equipment is safe to operate and in normal condition.
    b. Equipment with moving parts is properly lubricated.
    c. Temperature control systems are complete and operable.

d. Proper thermal overload protection is in place for electrical equipment.
e. Direction of rotation of all fans and pumps is correct.
f. Access doors are closed and end caps are in place.

2. Duct System Requirements:
a. All filters are clean and in place. If required, install temporary media.
b. Duct systems are clean and free of debris.
c. Fire/smoke and manual volume dampers are in place, functional and open.
d. Air outlets are installed and connected.
e. Duct system leakage has been minimized.

3. Pipe System Requirements:
a. Coil fins have been cleaned and combed.
b. Hydronic systems have been cleaned, filled, and vented.
c. Strainer screens are clean and in place.
d. Shutoff, throttling and balancing valves are open.

B. Report any defects or deficiencies to Architect/Engineer.

C. Promptly report items that are abnormal or prevent proper balancing.

D. If, for design reasons, system cannot be properly balanced, report as soon as observed.

E. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION

A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.

B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.04 INSTALLATION TOLERANCES

A. ± 10% of scheduled values:
1. Adjust air inlets and outlets to ± 10% of scheduled values.
2. Adjust piping systems to ±10% of design values.

B. ± 5% of scheduled values:
1. Adjust kitchen exhaust systems to ± 5% of scheduled values.

C. + 5% of scheduled values
1. Adjust outdoor air intakes to within + 5% of scheduled values.

D. Adjust supply, return, and exhaust air-handling systems to +10% / -5% of scheduled values.

3.05 ADJUSTING

A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.

B. Once balancing of systems is complete, at least one damper or valve must be 100% open.

C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.

D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.

E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

3.06 SUBMISSION OF REPORTS

A. Fill in test results on appropriate forms.

PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

4.01 GENERAL REQUIREMENTS

A. Title Page:
   1. Project name.
   2. Project location.
   3. Project Architect.
   4. Project Engineer (IMEG Corp.).
   5. TAB Company name, address, phone number.
   6. TAB Supervisor's name and certification number.
   7. TAB Supervisor's signature and date.
   8. Report date.

B. Report Index

C. General Information:
   1. Test conditions.
   2. Nomenclature used throughout report.
   3. Notable system characteristics/discrepancies from design.
   4. Test standards followed.
   5. Any deficiencies noted.
   6. Quality assurance statement.

D. Instrument List:
   1. Instrument.
   2. Manufacturer, model, and serial number.
   3. Range.
   4. Calibration date.

4.02 AIR SYSTEMS

A. Duct Leakage Test - all ductwork upstream of VAV boxes connected to AHU-1:
   1. Air system and fan.
   2. Leakage class.
   3. Test pressure.
   4. Construction pressure.
   5. Flow rate (cfm): specified and actual.
   6. Leakage (refer to Section 23 3100 in the specifications): specified and actual.
   7. Statement that fire dampers, reheat coils and other accessories were included in the test.
   8. Pass or Fail.
   9. Test performed by.
   10. Test witnessed by.

B. Air Moving Equipment:
   1. General Requirements:
      a. Drawing symbol.
      b. Location.

c. Manufacturer, model, arrangement, class, discharge.
d. Fan RPM.
e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
f. Final frequency of motor at maximum flow rate (on fans driven by VFD).

2. Flow Rate:
a. Supply flow rate (cfm): specified and actual.
b. Return flow rate (cfm): specified and actual.
c. Outside flow rate (cfm): specified and actual.
d. Exhaust flow rate (cfm): specified and actual.

3. Pressure Drop and Pressure:
a. Filter pressure drop: specified and actual.
b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
c. Inlet pressure.
d. Discharge pressure.

C. Fan Data:
1. Drawing symbol.
2. Location.
3. Manufacturer and model.
4. Flow rate (cfm): specified and actual.
5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure.
7. Discharge pressure.
8. Fan RPM.

D. Electric Motors:
1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

E. Air Terminal (Inlet or Outlet):
1. Drawing symbol.
2. Room number/location.
3. Terminal type and size.
4. Velocity: specified and actual.
5. Flow rate (cfm): specified and actual.
6. Percent of design flow rate.

F. Air Terminal Unit (Terminal Air Box) Data:
1. General Requirements:
a. Drawing symbol.
b. Location.
c. Manufacturer and model.
d. Size.
e. Type: constant, variable, single, dual duct.

2. Flow Rate:
    a. Cooling maximum flow rate (cfm): specified and actual.
    b. Heating maximum flow rate (cfm): specified and actual.
    c. Minimum flow rate (cfm): specified and actual.
3. Temperature:
    a. Entering air temperature: specified and actual.
    b. Leaving air temperature (in minimum airflow/heating mode): specified and actual.
4. Pressure Drop and Pressure:
    a. Inlet static pressure during testing cooling maximum airflow rate (maximum and minimum).
    b. Water pressure drop: specified and actual.

G. Air Flow Measuring Station:
1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

H. Kitchen Hoods:
1. Drawing symbol.
2. Location.
3. Manufacturer and Model.
4. Total flow rate (cfm): specified and actual.
5. Test velocities.
6. Hood opening dimensions.

4.03 HEATING SYSTEMS

A. Heating Coils:
1. General Requirements:
    a. Drawing symbol.
    b. Service.
    c. Location.
    d. Manufacturer and model.
    e. Size.
2. Flow Rate:
    a. Flow rate (cfm): specified and actual.
3. Temperature:
    a. Entering air temperature: specified and actual.
    b. Leaving air temperature: specified and actual.
4. Pressure Drop and Pressure:
    a. Air pressure drop: specified and actual.
5. Energy:
    a. Air Btuh (cfm x temp rise x 1.09).

4.04 COOLING SYSTEMS

A. Cooling Coils:

1. General Requirements:
    a. Drawing symbol.
    b. Service.
    c. Location.
    d. Size.
    e. Manufacturer and model.
2. Temperature:
    a. Entering air DB temperature: specified and actual.
    b. Entering air WB temperature: specified and actual.
    c. Leaving air DB temperature: specified and actual.
    d. Leaving air WB temperature: specified and actual.
3. Flow Rate:
    a. Flow rate (cfm): specified and actual.
4. Pressure Drop and Pressure:
    a. Air pressure drop: specified and actual.
5. Energy:
    a. Air Btuh (cfm x enthalpy change x 4.5).

4.05 PLUMBING SYSTEMS

A. Pump Data:

1. Drawing symbol.
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: operating and shutoff.
8. Discharge Pressure: operating and shutoff.

B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, model, frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

C. Balancing Valve:

1. Drawing symbol.
2. Service.
3. Location.
4. Size.
5. Manufacturer and model.
6. Flow rate (gpm): specified and actual.
7. Pressure drop: specified and actual.

D. Gas Fired Water Heater:
   1. Drawing symbol.
   2. Service.
   3. Location.
   4. Manufacturer and model.
   5. Capacity (Btuh): specified, nameplate, and actual.
   6. Entering water temperature: specified and actual.
   7. Leaving water temperature: specified and actual.
   8. Pressure Drop: specified and actual.
   9. Control Setting: specified and actual.

END OF SECTION

SECTION 23 0713
DUCTWORK INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Ductwork Insulation.

B. Insulation Jackets.

1.02 QUALITY ASSURANCE

A. Materials:

1. Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.

B. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include product description, list of materials and thickness for each service, and location.

B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.

B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum 'K' value at 75°F; foil scrim Kraft facing, 3 lb./cu. ft. density.

C. Type F: Flexible High Temperature Wrap; ASTM E2336 rating as 2-hour separation with zero clearance to combustible materials over the full length. Material to be totally scrim encapsulated. Material to be a minimum 1-1/2" thick with a minimum core density of 6 pcf. Wrap system should offer zero clearance to combustibles per ASTM E2336 at all locations, comply with all applicable codes, and be approved by AHJ. If system is not rated for zero clearance per ASTM E2336 at all locations with single layer, a two-layer system shall be provided with zero clearance per ASTM E2336 at all locations. Material must be tested and listed for installation on grease ducts and installed per listed design. Refer to Section 23 3300 for prefabricated, pre-insulated access doors required for grease duct systems.

2.02 JACKETS

A. Vapor Barrier Jackets: Kraft reinforced foil scrim vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 25 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.

B. Install materials after ductwork has been tested.

C. Clean surfaces for adhesives.

D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.

E. Exterior Duct Wrap - Flexible, Type A:

1. Apply with edges tightly butted.
2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
3. Seal joints with adhesive backed tape.
4. Apply so insulation conforms uniformly and firmly to duct.
5. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
6. Provide high-density insulation inserts on rectangular ducts at trapeze duct hangers to prevent crushing of insulation. Provide high-density insulation inserts with clamp-on round ducts requiring two (2) rods or straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
9. Staples may be used, but must be covered with tape.
10. Vapor barrier must be continuous.
11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

F. Semi Rigid Fiberglass Board Wrap - Type B (Indoor Use):

1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.
2. Space pins as needed to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.
4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.

G. Exterior Fire Protection, Flexible Type - Type F:

1. Cut and secure duct wrap around ductwork, support angles, and hangers per manufacturer's recommendations.
2. Seal all joints as required to maintain enclosure rating.
3. Installation shall be rated for 2 hours, unless otherwise noted.
4. Provide manufacturer's recommended assembly to protect all access doors to maintain enclosure rating and to permit easy replacement of insulation.

H. Continue insulation with vapor barrier through penetrations unless code prohibits.

I. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

3.02 SCHEDULE

A. Refer to Section 23 3100 for scheduling of insulation.

END OF SECTION

SECTION 23 0719
HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping Insulation.

B. Insulation Jackets.

1.02 QUALITY ASSURANCE

A. Materials: Listed and labeled for flame spread/smoke developed rating of no more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.01 INSULATION

A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, listed and labeled at more than 25/50 when tested per ASTM E84 or UL 723 as required by code. Maximum 1" thick per layer where multiple layers are specified.

C. Type C: Molded rigid cellular glass; ANSI/ASTM C-552; 0.29 maximum 'K' value at 75°F; density 7.3lb/ft; minimum compressive strength 90 psi parallel to rise; moisture resistant, non-combustible; suitable for -100°F to +900°F. For below grade installations use asphaltic mastic paper vapor barrier jacket. Use self-seal all-purpose polymer or polypropylene service jacket for above grade installations.

D. Type D: Hydrous Calcium Silicate; ASTM C533; rigid molded pipe insulation; asbestos free; 0.40 'K' value at 300°F; 1200°F maximum service temperature; 16 gauge stainless steel tie wires on maximum 12" centers.

E. Type E: Preformed rigid cellular polyisocyanurate insulation; ANSI/ASTM C591; maximum 'K' value of 0.19 at 75°F; density 4.0lb/ft; minimum compressive strength 95 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -297°F to +300°F.

F. Type F: Phenolic insulation; ASTM C1126; maximum 'K' value of 0.22 at 75°F; density 3.75lb/ft; minimum compressive strength 50 psi parallel to rise; moisture resistant; listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code; suitable for -290°F to +250°F.

2.02 VAPOR BARRIER JACKETS

A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

B. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

2.03 JACKET COVERINGS

A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use.

B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. Listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

B. Patch and repair torn insulation. Paint to match adjacent insulation surface.

3.02 INSTALLATION

A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
3. All piping and insulation that does not meet 25/50 that is in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has been listed and labeled having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested as a composite in accordance with ASTM E84 or UL 723.
4. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall studs, and the insulation shall butt up to each stud.

B. Insulated Piping Operating Below 60°F:

1. Insulate fittings, valves, unions, flanges, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves and strainers with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow access for reading and adjusting of the balancing valve and cleaning and servicing of the balancing valve.

C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140°F:

1. Insulate fittings, valves, flanges, float & thermostatic steam traps, and strainers. On gate valves, the insulation shall be extended to cover the entire valve bonnet, leaving only the portion of the stem that is above the bonnet and valve operator exposed.
2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
3. The use of removable insulation jackets is acceptable for insulating large and non-cylindrical shaped piping components (e.g., check valves, pressure regulating valves, calibrated balance valves, gate valve bonnets, F&T traps, strainers, line sets, and the like).

E. Refrigerant Piping:

1. On refrigerant piping (25°F and above) and not required to meet the 25/50 flame/smoke, provide at each strut or clevis support an insulation coupling to support pipe and to accept insulation thickness of adjoining insulation, to prevent insulation from sagging and crushing. The coupling shall be suitable for planned temperatures, use with specified pipe material, and shall be a 360°, one-piece cylindrical segment. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Contractor shall apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.

F. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

3.03 SUPPORT PROTECTION

A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.

B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
    a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    b. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" to 10". For pipe sizes larger than 10", provide rolled steel plate in addition to the shield. Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall be listed and labeled at no more than 25/50 when tested per ASTM E84 or UL 723 as required by code.
    c. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14, provide rolled steel plate in addition to the shield.
    d. Phenolic (for pipes operating below 250°F with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
    e. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
        1) Products:
            a) Buckaroo CoolDry
            b) Cooper/B-Line Fig. B3380 through B3384
            c) Pipe Shields A1000, A2000
    f. Insulation Couplings:
        1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.

2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
   a) Klo-Shure or equal
3) Vertical Manufacturers:
   a) Manufacturers: Klo-Shure Titan or equal

g. Rectangular blocks, plugs, or wood material are not acceptable.

h. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5” to 6"	18" long x 16 gauge
8” to 14"	24" long x 14 gauge
16” to 24"	24" long x 12 gauge

F. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 23 0529 "HVAC Supports and Anchors".

G. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

3.04 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.
4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer’s instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.

3. Insulation Installation on Straight Pipes and Tubes:
    a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
    b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.
4. Insulation Installation on Valves and Pipe Specialties:
    a. Install preformed sections of same material as straight segments of pipe insulation when available.
    b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
    c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type C Insulation:
1. Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner.
2. Insulate fittings with prefabricated fittings.

D. Type D Insulation:
1. Use pre-molded half sections. Butt longitudinal and circumferential joints tightly. Wire in place with 16 gauge stainless steel wire on maximum 12" centers.
2. Apply in two layers. Stagger all joints between layers. Wire each layer individually.

E. Type E Insulation:
1. Indoors, above grade or below grade, Polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
2. Insulate pipe fittings with prefabricated insulation fittings.

F. Type F Insulation:
1. Seal all longitudinal joints with manufacturer approved adhesive or mastic. Secure butt joint strips in a similar manner.
2. Indoors, above grade or below grade, polyvinylidene chloride (PVDC or Saran) vapor retarder film and tape: Seal all longitudinal joints with manufacturer approved adhesive. Secure butt joint strips in a similar manner. Refer to manufacturer's recommendations for installation guidelines.
3. Insulate pipe fittings with prefabricated insulation fittings.

3.05 JACKET COVER INSTALLATION

A. Metal Covering:
1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.
2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.
3. Interior joints do not need to be sealed.
4. Use metal covering on the following pipes:
    a. All exterior piping.

B. Plastic Covering:
1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.

3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. All joints in areas noted shall meet USDA standards for Totally Sealed Systems, including overlaps of 1" on circumferential and 1.5" to 2" on longitudinal seams.
5. Use plastic insulation covering on all exposed pipes including, but not limited to:
    a. All exposed piping in finished spaces.
    b. All exposed piping below 8'-0" above floor.
    c. All piping in mechanical rooms and/or tunnels that is subject to damage from normal operations. (Example: Piping that must be stepped over routinely.)
    d. All kitchen areas.

3.06 SCHEDULE

A. Refer to drawings for insulation schedule.

END OF SECTION

SECTION 23 0800
HVAC COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Provider (CxP) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
   1. Control system.
   2. Major and minor equipment items.
   3. Piping systems and equipment.
   4. Ductwork and accessories.
   5. Terminal units.
   6. Variable frequency drives.
   7. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.

B. Section 017900 - Demonstration and Training: Scope and procedures for Owner personnel training.

C. Section 019113 – General Commissioning Requirements

1.03 REFERENCE STANDARDS

A. ASHRAE Guideline 0-2013 – The Commissioning Process.

B. ASHRAE Standard 202-2018 - Commissioning Process for Buildings and Systems.

1.04 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Provider informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
   1. System name.
   2. List of devices.
   3. Step-by-step procedures for testing each controller after installation, including:
      a. Process of verifying proper hardware and wiring installation.
      b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
      c. Process of performing operational checks of each controlled component.

d. Plan and process for calibrating valve and damper actuators and all sensors.
e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.

4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.
5. Description of the instrumentation required for testing.
6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Provider and TAB contractor for this determination.

C. Startup Reports and Trend Logs: Submit for approval of Commissioning Provider.

D. HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
1. Full as-built set of control drawings.
2. Full as-built sequence of operations for each piece of equipment.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

C. The building automation system (BAS) contractor shall provide a temporary username and password login to the BAS for the CxP, which can be read only.

PART 3 EXECUTION

3.01 GENERAL

A. Cloud based software will be utilized for maintaining Prefunctional Checklists, Functional Performance Testing and Issue management. Contractors will be required to utilize the system. Logins will be provided to the contractors, and the software does not require a subscription fee from the contractors.

3.02 PREPARATION

A. Cooperate with the Commissioning Provider in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Provider.

C. Prepare a preliminary schedule for HVAC pipe and duct system testing, flushing and cleaning, equipment start-up and testing, adjusting, and balancing start and completion for use by the Commissioning Provider; update the schedule as appropriate.

D. Notify the Commissioning Provider when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and testing, adjusting, and balancing will occur; when commissioning activities not yet performed or not yet scheduled will delay construction notify ahead of time and be proactive in seeing that the Commissioning Provider has the scheduling information needed to efficiently execute the commissioning process.

E. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.

F. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing, close with an approved plug.

G. Provide temperature and pressure taps in accordance with Contract Documents.

3.03 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Provider for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Valve/Damper Stroke Setup and Check:
   1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
   2. Set pump/fan to normal operating mode.
   3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
   4. Command valve/damper open; verify position is full open and adjust output signal as required.
   5. Command valve/damper to a few intermediate positions.
   6. If the actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

E. Isolation Valve or System Valve Leak Check: For valves not by coils.
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

F. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.04 TAB COORDINATION

A. TAB: Testing, adjusting, and balancing of HVAC.

B. Coordinate commissioning schedule with TAB schedule.

C. Review the TAB plan to determine the capabilities of the control system toward completing TAB.

D. Provide all necessary unique instruments and instruct the TAB technicians in their use, such as handheld control system interface for setting terminal unit boxes, etc.

E. Have all required Prefunctional Checklists, calibrations, startup and component Functional Tests of the system completed and approved by the Commissioning Provider prior to starting TAB.

F. Provide a qualified control system technician to operate the controls to assist the TAB technicians or provide sufficient training for the TAB technicians to operate the system without assistance.

3.05 FUNCTIONAL TESTING

A. Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.

C. Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Provider.

D. The Contractor is responsible to ensure that equipment is ready for functional testing with the CxP which means the equipment will pass the measures in the test procedures previously submitted for their review and use. The responsible subcontractors use these written test procedures to checkout their equipment and shall dynamically run (not by simulation) the

equipment through the test procedures prior to testing with the CxP, unless exempted elsewhere in the specifications. The installing and automated controls contractors shall sign the test procedure attesting to this successful pre-test execution and final test readiness prior to functional testing with the CxP.

E. Prior to testing with the CxP, trending and archiving must have been set up by the BAS Controls contractor and is active for all points that are relevant for verifying proper operation or for troubleshooting

F. Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
   1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
   2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.

G. Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.

H. Demonstrate the following to the Commissioning Provider during testing of controlled equipment, coordinate with commissioning of equipment.
   1. Setpoint changing features and functions.
   2. Sensor calibrations.

I. Demonstrate to the Commissioning Provider:
   1. That all specified functions and features are set up, debugged and fully operable.
   2. That scheduling features are fully functional and setup, including holidays.
   3. That all graphic screens and value readouts are completed.
   4. Correct date and time setting in central computer.
   5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent, if any of those fail test all remaining units at no extra cost to Owner.
   6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
   7. Power failure and battery backup and power-up restart functions.
   8. Global commands features.
   9. Security and access codes.
   10. Occupant over-rides (manual, telephone, key, keypad, etc.).
   11. O&M schedules and alarms.
   12. Occupancy sensors and controls.
   13. Communications to remote sites.
   14. Fire alarm interlocks and response.
   15. Fire protection and suppression systems interfaces.
   16. That points that are monitored only, having no control function, are reporting properly to the control system.
   17. All control strategies and sequences not tested during controlled equipment testing.
   18. Trend logging and graphing features that are specified.
   19. Other integrated tests specified in Contract Documents
   20. That control system features that are included but not specified to be setup are actually installed.

J. If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.06 DEMONSTRATION AND TRAINING

A. See Section 01 7900 for additional requirements.

B. Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Provider during Functional Testing.

D. Provide hands-on training of Owner's designated personnel on operation and maintenance of the HVAC system, control system, and all equipment items indicated to be commissioned.

E. Provide the services of manufacturer representatives to assist instructors where necessary.

F. Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION

SECTION 23 0900
CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Complete System of Automatic Controls.

B. Control Devices, Components, Wiring and Material.

C. Instructions for Owners.

D. Remodeling.

1.02 QUALITY ASSURANCE

A. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

1.03 SUBMITTALS

A. Equipment Coordination:

1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
2. Control valve selections shall be based on flow rates shown in approved shop drawings.
3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.

B. Shop Drawings:

1. Submit shop drawings per Section 23 0500. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:
    a. Wiring diagrams and layouts for each control panel showing all termination numbers.
    b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
    c. Identification of all control components connected to emergency power.
    d. Schematic diagrams for all field sensors and controllers.
    e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
    f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
    g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.

h. All installation details and any other details required to demonstrate that the system will function properly.

i. All interface requirements with other systems.

6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.

7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.

8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.

9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:

   a. Damper Identification Tag.

   b. Location.

   c. Damper Type.

   d. Damper Size.

   e. Duct Size.

   f. Arrangement.

   g. Blade Type.

   h. Velocity.

   i. Pressure Drop.

   j. Fail Position.

   k. Actuator Identification Tag.

   l. Actuator Type.

   m. Mounting.

10. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:

    a. Valve Identification Tag.

    b. Location.

    c. Valve Type.

    d. Valve Size.

    e. Pipe Size.

    f. Configuration.

    g. Flow Characteristics.

h. Capacity.

i. Valve C_V.

j. Design Pressure Drop.

k. Pressure Drop at Design Flow.

l. Fail Position.

m. Close-off Pressure.

n. Valve and Actuator Model Number and Type.

11. Indoor modular air handling units (Section 23 7313) and mixed flow return air fans (Section 23 3413) provided under this project will have piezometer type sensors mounted at fan inlets by fan manufacturer. Fan manufacturer will provide fan specific flow coefficients and equations that can be used to calculate fan airflow based on measured pressure differential at fan inlet. TCC shall provide the following:

    a. Quantity of pressure transducers so that each individual fan is served by a dedicated pressure transducer. Each pressure transducer shall have a range that is selected based on scheduled maximum airflow for each fan. TCC shall submit a schedule that shows the following calculations for each fan/pressure transducer:

        1) Pressure drop at maximum scheduled airflow for each fan using fan manufacturer's flow coefficient.

        2) Recommended transducer range.

    b. Pneumatic tubing as required to interconnect all piezometer type sensors and pressure transducer.

    c. Fasteners and supports as required to securely attached tubing, pressure transducers, conduits, wiring, and the like for a complete installation.

12. Airflow Measuring Station Schedule:

    a. The manufacturer's authorized representative shall prepare the airflow measuring station submittal, or review and approve in writing the submittal prepared by the TCC prior to submission to the Architect/Engineer and prior to installation. The representative shall review air handling equipment submittals and duct fabrication drawings to ensure that all AFMS locations meet the appropriate parameters to achieve proper installation and the specified accuracy. Comply with all manufacturer's installation requirements including straight up and downstream duct lengths. Install airflow straighteners if required by the manufacturer based on installation constraints. The Architect/Engineer shall be notified for approval of any deviations.

    b. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.

    c. Submit installation, operation, and maintenance documentation.

13. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.

14. Provide PICS files indicating the BACnet functionality and configuration of each device.

15. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version

that meets BTL testing and listing requirements if problems are found during BTL testing is required.

16. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation.
17. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
18. Clearly identify work by others in the submittal.
19. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 23 0500, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:
    a. Table of contents with indexed tabs dividing information as outlined below.
    b. Definitions: List of all abbreviations and technical terms with definitions.
    c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
    d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
    e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
    f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.
    g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
    h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
    i. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
    j. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project.

D. Training Manual:

1. Provide a course outline and training manuals for each training class.

E. Record Documents:

1. Submit record documentation per Section 23 0500.
2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD™ or Visio™ compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall

also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.

3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.

1.04 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.05 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Control Valves.

B. Temperature Sensor Sockets.

C. Gauge Taps.

D. Automatic Dampers.

1.06 AGENCY AND CODE APPROVALS

A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.

1. UL-916; Energy Management Systems.
2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
3. EMC Directive 89/336/EEC (European CE Mark).
4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.07 ACRONYMS

A. Acronyms used in this specification are as follows:

1. B-AAC BACnet Advanced Application Controller
2. B-ASC BACnet Application Specific Controller
3. BTL BACnet Testing Laboratories
4. DDC Direct Digital Controls
5. FMCS Facility Management and Control System
6. GUI Graphic User Interface
7. IBC Interoperable BACnet Controller
8. IDC Interoperable Digital Controller
9. LAN Local Area Network
10. NAC Network Area Controller
11. ODBC Open DataBase Connectivity
12. OOT Object Oriented Technology
13. OPC Open Connectivity via Open Standards
14. PICS Product Interoperability Compliance Statement
15. PMI Power Measurement Interface

16. POT Portable Operator's Terminal
17. TCC Temperature Control Contractor
18. TCS Temperature Control System
19. WAN Wide Area Network
20. WBI Web Browser Interface

1.08 SUMMARY

A. Extend Existing System:

1. Extend the existing FMCS for this project. The existing facility has a Johnson Controls system with the head end computer located in the MHI building and another workstation in the CCF building. There is an existing BACnet engine that has space capacity for a BACnet trunk located in the CCF building at the south west corner maintenance office as noted on sheet M1.3. Jim Peavler with Johnson Controls out of Omaha has additional information on the existing system. His contact number is 402-891-5843.

B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.

C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.

D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

1.09 SYSTEM DESCRIPTION

A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.

B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.

C. Provide materials and labor necessary to connect factory supplied control components.

D. Provide central and remote hardware, software, and interconnecting wire and conduit.

E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.

F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.

G. For each operator workstation provided, furnish one legal copy of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be readily available in the market. Contractor shall convey to the Owner all software tools and their legal licenses at project closeout.

1.10 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

1.11 WARRANTY

A. Refer to Section 23 0500 for warranty requirements.

B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.

C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.

D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

1.12 WARRANTY ACCESS

A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. BACnet Protocol:

1. Johnson Controls: Metasys Extended Architecture

2.02 SYSTEM ARCHITECTURE

A. General:

1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.

2. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

B. Open, Interoperable, Integrated Architectures:

1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.

2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs are not acceptable.

3. Hierarchical or "flat" topologies are required to have system response times as indicated below and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network.

a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.

b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.03 NETWORKS

A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE Standard 802.3.
2. Cable; 100 Base-T, UTP-8 wire, Category 6.
3. Minimum throughput; 100 Mbps.

C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.

D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.

E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

2.04 NETWORK AREA CONTROLLER (NAC)

A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.

B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:

1. Calendar functions.
2. Scheduling.
3. Trending.
4. Alarm monitoring and routing.
5. Time synchronization.
6. Integration of all controller data.
7. Network Management functions.

C. The Network Area Controller shall provide the following hardware features as a minimum:

1. One Ethernet Port - 10/100 Mbps.
2. One RS-232 port.
3. One LonWorks Interface Port - 78KB FTT-10A (for LonWorks systems only).
4. One RS-485 port.
5. Battery backup.
6. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
7. The NAC must be capable of operation over a temperature range of 32°F to 122°F.
8. The NAC must be capable of withstanding storage temperatures of between 0°F and 158°F.
9. The NAC must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.

D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the NAC shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.

F. Event Alarm Notification and Actions:

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
    a. Alarm
    b. Normal
4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g., security, HVAC, Fire, etc.
5. Provide timed (scheduled) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Treat control equipment and network failures as alarms and annunciated.

H. Annunciate alarms in any of the following manners as defined by the user:

1. Screen message text.
2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
    a. Day of week.
    b. Time of day.
    c. Recipient.
3. Pagers via paging services that initiate a page on receipt of e-mail message.
4. Graphic with flashing alarm object(s).
5. Printed message, routed directly to a dedicated alarm printer.

I. The FMCS shall record the following for each alarm:

1. Time and date.
2. Location (building, floor, zone, office number, etc.).
3. Equipment tag.
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

J. Give defined users proper access to acknowledge any alarm.

K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

L. Provide a "query" feature to allow review of specific alarms by user-defined parameters.

M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

2.05 BACNET FMCS

A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).

C. Interoperable BACnet Controller (IBC):

1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system's compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
    a. BACnet Building Controller(s) (B-BC).
    b. BACnet Advanced Application Controller(s) (B-ACC).
    c. BACnet Application Specific Controller(s) (B-ASC).
3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.
6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
    a. BACnet Device; MAC address, name, type and instance number.
    b. BACnet Objects; name, type and instance number.
7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.

D. Object Libraries:

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.

4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
    a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.
    b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
    c. Override Object: Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
    d. Start-Stop Time Optimization Object: Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.
    e. Demand Limiting Object: Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.
6. The library shall include control objects for the following functions:
    a. Analog Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
    b. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.
    c. Binary Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
    d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.

e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.

f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.

i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.

j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.

k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.

7. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). Provide the following as part of the standard library included with the programming software:

a. LonMark/LonWorks Devices: These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. Support all network variables defined in the LonMark profile. The device manufacturer shall provide information (type and function) regarding network variables not defined in the LonMark profile.

b. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file, and documentation for the device to facilitate device integration.

c. For BACnet devices, provide the following objects:

1) Analog In.

2) Analog Out.

3) Analog Value.

4) Binary.
5) Binary In.
6) Binary Out.
7) Binary Value.
8) Multi-State In.
9) Multi-State Out.
10) Multi-State Value.
11) Schedule Export.
12) Calendar Export.
13) Trend Export.
14) Device.

d. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

e. For BACnet devices, provide the following support at a minimum:
1) Segmentation.
2) Segmented Request.
3) Segmented Response.
4) Application Services.
5) Read Property.
6) Read Property Multiple.
7) Write Property.
8) Write Property Multiple.
9) Confirmed Event Notification.
10) Unconfirmed Event Notification.
11) Acknowledge Alarm.
12) Get Alarm Summary.
13) Who-has.
14) I-have.
15) Who-is.
16) I-am.
17) Subscribe COV.
18) Confirmed COV notification.
19) Unconfirmed COV notification.
20) Media Types.
21) Ethernet.
22) BACnet IP Annex J.
23) MSTP.
24) BACnet Broadcast Management Device (BBMD) function.
25) Routing.

2.06 TERMINAL AIR BOX (TAB) CONTROLLERS

A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 23 3600 for additional information.

B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.

C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.

D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.

E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.

F. BACnet TAB controllers shall either be B-AAC devices or B-ASC devices as required to meet the performance and BTL listing.

2.07 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

A. The NAC shall be able to collect data for any property of any object and store resident in the NAC that shall have, at a minimum, the following configurable properties:

1. Designating the log as interval or deviation.
2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

B. Store all log data in a relational database in the NAC that is accessible from a server (if the system is so configured) or a standard Web browser.

C. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

D. All log data shall be available to the user in ALL the following data formats:

1. HTML.
2. XML.
3. Plain text.
4. Comma or tab separated values.

E. The NAC shall archive its log data either locally (to itself) or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties:

1. Archive on time of day.
2. Archive on user-defined number of data stores in the log (buffer size).
3. Archive when log has reached its user-defined capacity of data stores.
4. Provide ability to clear logs once archived.

2.08 AUDIT LOG

A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:

1. Time and date.
2. User ID.
3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

2.09 DATABASE BACKUP AND STORAGE

A. The NAC shall automatically backup its database on a user-defined time interval.

B. Store copies of the current database and, at the most, the recently saved database in the NAC. The age of the most recently saved database shall depend on the user-defined database save interval.

C. Store the NAC database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

2.10 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. A UPS shall be provided for each of the following:

1. Network area controllers.

B. Provide a 120-volt 60 Hz line-interactive uninterruptible power supply with backup battery capacity for 5 minutes at 100% load. UPS shall have hot swappable batteries, automatic battery self-test and start-on-battery capabilities. Batteries shall be valve regulated, sealed lead acid type. UPS shall have sine wave shape output waveform. UPS shall be UL 1778 list and comply with FCC Part 15, Class A.

C. Manufacturers:

1. Sola/Hevi-Duty
2. Eaton Powerware
3. APC

2.11 SYSTEM PROGRAMMING

A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.

B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.

C. Programming Methods:

1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.
2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.12 DDE DEVICE INTEGRATION

A. The NAC shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The NAC shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:

1. DDE Generic AI Object.
2. DDE Generic AO Object.
3. DDE Generic BO Object.
4. DDE Generic BI Object.

2.13 MODBUS SYSTEM INTEGRATION

A. The NAC shall support integration of device data from Modbus RTU, ASCII, and TCP control system devices. Connect to the Modbus system via an RS-232, RS485, or Ethernet IP as required by the device.

B. Provide the required objects in the library included with the GUI programming software to support the integration of the Modbus system data into the FMCS. Objects provided shall include, at a minimum:

1. Read/Write Modbus AI Registers.
2. Read/Write Modbus AO Registers.
3. Read/Write Modbus BI Registers.
4. Read/Write Modbus BO Registers.

C. The NAC shall perform all scheduling, alarming, logging and global supervisory control functions of the Modbus system devices.

D. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment using Modbus shall provide documentation of the system's Modbus interface and shall provide factory support at no charge during system commissioning.

2.14 CONTROL DAMPERS

A. Rectangular Control Dampers - Standard Construction:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid stainless steel with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.

6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
11. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24" x 24" damper (2000 fpm).
13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24" x 24" damper (2000 fpm).

B. Thermally Insulated Control Damper:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Extruded aluminum, minimum 4" deep, 0.080" minimum thickness.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, internally insulated with expanded polyurethane foam and thermally broken, with overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid stainless steel shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
8. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
9. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
10. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
11. Maximum Pressure Drop: 0.21" for 8,000 cfm through a 24" x 24" damper (2000 fpm).

2.15 DAMPER ACTUATORS

A. Damper Actuators - Electronic:

1. Actuator shall be UL 873 or 60730 listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation. Mount actuator by means of a V-bolt dual nut clamp with a V-shaped toothed cradle, directly couple and mount to the valve bonnet stem, or ISO-style direct-coupled mounting pad. Actuators shall be capable of being mechanically and electrically paralleled to increase torque, if required.
2. Actuators shall be warranted for a period of five (5) years from the date of production, with the first two (2) years unconditional.
3. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
4. Fail-Safe Dampers: Where shown on the drawings or sequences, fail-safe mechanism shall operate the damper to the fail position following power interruption.
    a. Mechanical/Spring: Mechanical spring return mechanism to drive controlled drive to an end position (open or close) on loss of power.
    b. Electronic: Electronic fail-safe shall incorporate an active balancing circuit to maintain equal charging rates among the capacitors. The power fail position shall be proportionally adjustable between 0 to 100% in 10 percent increments with a 10 second operational delay.
5. Feedback: Where shown on drawings or sequences, provide analog feedback signal for positive position indication.
6. Damper End Switches: Where shown on the drawings or sequences, provide end switches to prove damper reaches open/closed position.

2.16 CONTROL INSTRUMENTATION

A. Temperature Measuring Devices:

1. Electric Thermostats:
    a. Single Temperature - Line Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, concealed temperature adjustment, locking cover, rated for load, single or double pole as required.
    b. Single Temperature - Low Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, anticipator circuits, concealed temperature adjustment, locking cover, 24 V control transformer (if not included with unit under control), single or double pole as required.
2. Low Limit Switch:
    a. Provide one foot of sensing element for each one square foot of coil area, maximum element length 25 feet, of the vapor tension type, so that any point along the entire length of measuring element can trigger the switch.
    b. Provide 3" minimum radius capillary support clips at each turn.
    c. Furnish each thermostat with one single pole, single throw normally-opened switch and one single pole, single throw normally-closed auxiliary switch.
    d. Setpoint range shall be 15°F to 55°F with a permanent stop at 35°F.
    e. Differential shall be fixed at approximately 5°F and supplied with manual reset.

B. Temperature Sensors:

1. Room Temperature Sensor:
    a. Sensor Only: Stainless steel face plate sensor with flush mounting and tamper proof installation and screws, hermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, ± 0.50°F accuracy, no setpoint adjustment or override button.
2. Duct Temperature Sensor:

a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.

3. Water Temperature Sensor:

a. Install in immersion wells. Separate thermometers as specified elsewhere, also of the immersion well type, shall be installed within 2 feet of each temperature sensor.

C. Humidity Measuring Devices:

1. Humidity Sensors:

a. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be minimum of 2.0 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH humidity at temperatures from 50°F to 104°F.

2. Humidistats:

a. Room Humidistats: Wall-mounted, proportioning type, with adjustable 2% RH throttling range, operating range from 30% to 80% at temperatures up to 110°F, cover with concealed setpoint. Accuracy shall be minimum of 1.5 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH at temperatures from 50°F to 104°F.

D. Enthalpy Sensors: Duct-mounted enthalpy sensor shall include solid state temperature and humidity sensors with electronics that shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

E. Pressure Measuring Devices

1. Differential Pressure Switches:

a. Standard Pressure Switches:

1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.

2) Accuracy shall be ± 3% of full scale maximum throughout entire range at 70°F.

3) Provide mounting brackets, probes, and shutoff valves required for proper installation.

4) The range and service shall be as required for application or as noted on the drawings.

5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.

6) Provide latching relays that require manual reset once activated.

7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.

b. High Pressure Switches (Manual Reset):

1) Differential pressure switch with single pole, double-throw snap switch and enclosure.

2) Rated for pressure specified in sequence of control.

3) Electrical rating shall be 15 amps at 120-480 volts.

4) Setpoint adjustment shall be screw type located inside enclosure.

5) Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.

6) Repeatability: ±± 3%.

2. Pressure Transmitters/Transducer:

a. Air-to-Air:

1) Provide transducer having the following minimum performance for measuring duct static pressure for VFD control or measuring differential pressure across filter banks:

a) Accuracy: ±1.0% FS

b) Non-Linearity, BFSL: ±0.96% FS

c) Hysteresis: 0.10% full scale

d) Non-Repeatability: 0.05% full scale

e) Thermal Effects (compensated range): 0°F to +150°F

f) Maximum Line Pressure: 10 PSI

g) Zero/Span Shift: 0.033%FS/°F

h) Long Term Stability: 0.5%FS/1year

2) Provide transducer with the following minimum performance for measuring differential pressure across piezometer fan inlet airflow measuring stations:

a) Unit shall come factory equipped with static tube attached.

b) Unit shall include: (1) LCD shall display differential pressure on face of sensor enclosure over the entire operational range, and (2) IPCC-rated polycarbonate enclosure with short circuit proof outputs and reverse polarity protected inputs.

c) Accuracy at 72°F: ±0.25% FS

d) Stability: ±0.25% full scale per year

e) Temperature Error: (1) Zero: ±0.025% full scale per °C, (2) Span: Maximum ±0.03% full scale per °C

f) Environmental Operating Range: 32°F to 140°F.

g) Overpressure: Proof: (1) 2 psi, (2) Burst: 3 psi

h) Humidity: 0% to 95% RH non-condensing.

F. Flow Measuring Devices:

1. Airflow Measuring Stations:

a. Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion:

1) Provide airflow/temperature measurement devices where indicated on the plans.

2) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

a) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

b) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.

c) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.

d) Devices using less than two thermistors in each sensor assembly are not acceptable.

e) Devices using platinum wire RTDs are not acceptable.

f) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.

g) Pitot tubes and arrays are not acceptable.

h) Vortex shedding devices are not acceptable.

3) All Sensor Probes:

a) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.

b) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).

c) Airflow measuring station assembly accuracy shall be ± 2% of Reading over the entire operating airflow range. Temperature accuracy shall be ± 0.15° F between -20° F and 160° F.

d) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).

e) Each sensor probe shall have an integral, UL listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

f) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.

4) Duct and Plenum Probes:

a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.

b) Probe assembly mounting brackets shall be constructed of 304 stainless steel.

c) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

5) Sensor Density:

Area (sq. ft.)	**Total # of Sensors Required**
Less than 2	4
2 to less than 4	6
4 to less than 8	8
8 to less than 16	12
≥ 16	16

6) Transmitters:

a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.

b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.

c) The operating temperature range for the transmitter shall be -20° F to 120° F.

d) The transmitter shall be capable of communicating with other devices using one of the following interface options:

e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)

f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.

h) Option 4: LonWorks Free Topology

b. Fan Inlet Airflow Measuring Stations (AFMS) - Thermal Dispersion:
   1) Sensor assemblies shall be mounted on 304 stainless steel housings.
   2) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
   3) Mounting feet shall be constructed of 304 stainless steel and securely riveted in place to prevent loosening over time due to vibration.
   4) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
   5) Transmitters
      a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
      b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
      c) The operating temperature range for the transmitter shall be -20° F to 120° F.
      d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
      e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
      f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
      g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
      h) Option 4: LonWorks Free Topology
   6) The AFMS shall be UL listed as an entire assembly.

c. Fan Inlet Airflow Measuring Stations - Differential Pressure:
   1) Fan Inlet Measuring Station Pressure Sensors, Transmitters and Transducers:
      a) Select for appropriate pressure range, fan type, inlet velocity, and airflow volume.
      b) Transmitter features and minimum performance requirements shall be as follows: (1) Combined Accuracy: ± 0.50%, (2) Terminal Point Nonlinearity: ± 0.40%, (3) Hysteresis: ± 0.02%., (4) Non-repeatability: ± 0.05%, (5) Compensation Range - Zero Shift: ±0.025% FS/°F, Span Shift: 0.025% FS/°F, (6) Differential Overpressure: 5 psi proof and 25 psi burst pressure, (7) Output signal: 0 to 10 VDC.
      c) Each transducer shall be provided with an integral manual zeroing valve to allow for field calibration of the zero-reference value without the need for shutting the operating system down.
      d) System airflow (measured in CFM) shall be continuously displayed on an LCD display meter (0.5 inches high by 3.5 digits) located on the face of the air volume/velocity transducer control enclosure.

d. Mounting of fan inlet static pressure sensing elements shall be in accordance with manufacturer's published installation instructions to ensure accuracy of readings.

G. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:

a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:

a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

H. Miscellaneous Devices:

1. Application Specific Controller Power Supply:

a. For use with terminal air box.

b. Provide multiple enclosures with the following accessories and components as required to provide 24VAC power to terminal air boxes, differential pressure monitors, damper actuators, valve actuators, and other components and devices as required.

c. NEMA-1 steel enclosures (12"x12"x6") with separate high and low voltage compartments and separate access covers.

d. Either one 300 VA power supply with three 100 VA Class 2 outputs, or one 500 VA power supply with five 100 VA Class 2 outputs.

e. Primary side shall receive 480/277/240/120 input to 24 VAC ungrounded, isolated output on the secondary side.

f. Each secondary output shall include a 4 amp breaker, on/off switch, and LED indicator. Terminal blocks shall accept 16-22 AWG wire.

g. Acceptable Manufacturer:

1) RIB Functional Devices Model MSH300A-LVC or PSH500A-LVC

2. Control Relays:

a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.

b. Mount all relays and power supplies in a NEMA 12 enclosure beside the FMCS panel or controlled device and clearly label their functions.

I. Outdoor Weather Station:

1. Outdoor rated ventilated plastic enclosure, off-white color, radiation shield including the following parameters.

2. Measured Parameters:

a. Temperature Sensor: Thermistor sensing element or resistance temperature device (RTD).

1) Operating Range: -40°F to 140°F

2) Accuracy: ± 0.54°F at 68°F

b. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service.
   1) Measurement Range: 0-100% RH
   2) Accuracy:
      a) ± 3% of reading from 0%-90% RH at 50°F to 86°F
      b) ± 5% of reading from 0%-90% RH at -4°F to 50°F and 86°F to 140°F.

3. Calculated Parameters:
   a. Dew Point Temperature in °F
   b. Wet Bulb Temperature in °F
   c. Enthalpy. Enthalpy sensor shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

2.17 CONDUIT AND BOXES

A. Conduit and Boxes: Refer to Electrical Section 26 0533 for materials, sizing, and other requirements

B. Conduit and Box Identification (Color and Labeling):
   1. Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for raceway and box color requirements.
   2. Refer to Electrical Section 26 0553 for raceway and box labeling requirements.

2.18 WIRE AND CABLE

A. Wire and Cable: Refer to Electrical Section 26 0513 for wire and cable materials.
   1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the mechanical cover sheet for wire and cable color requirements.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.

B. Install system and materials in accordance with manufacturer's instructions.

C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.

D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.

E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed ADA mounting requirements.

F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.

G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.

H. After completion of installation, test and adjust control equipment.

I. Check calibration of instruments. Recalibrate or replace.

J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.

K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall be powered from the optional standby branch of emergency power. In no instance shall panel be connected to the life safety or critical branch of the emergency power system. Panels may be connected to a common 20 amp, 120 volt circuit provided the total load on the circuit does not exceed 16 amps. Circuit conductors shall be sized per the table below. All power connections to the control panels shall be performed by a licensed electrician at the cost of this Contractor. Submit circuit information (total amperage on circuit, conductors length, and panel) for control panels to the Architect/Engineer for approval.

Circuit Load (Amps)	Circuit Max Length	Feeder Size
≤ 5	≤ 200ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 10	≤ 100ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 16	≤ 75ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 200	≤ 325ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 100	≤ 160ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 75	≤ 100ft	2#10 & 1#10 ground in 3/4" conduit.

L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.

M. Remodeling:

1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. If wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.

N. Labels For Control Devices:

1. Provide labels indicating service of all control devices in panels and other locations.
2. Labels may be made with permanent marking pen in the control panels if clearly legible.
3. Use engraved labels for items outside panel such as outside air thermostats.
4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.

O. VFDs:

1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.
2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.
3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.
4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.

5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

P. Airflow Stations:

1. The transmitter shall be installed at a location that is protected from weather, water, and vibration.
2. Mount transmitter where they can easily be read (36" to 66" above floor). Do not fasten transmitters directly to ductwork or compromise duct insulation.
3. The manufacturer's authorized representative shall visit the project site during construction prior to station installations to confirm all submitted sizes, mounting requirements and locations. Size adjustments shall be made at no additional cost. The representative shall meet on site with the TCC to support and train them on proper installation procedures and calibration.
4. Install labels at each sensor and transmitter identifying its service.

3.02 GRAPHIC DISPLAY

A. Create a customized graphic for each piece of equipment indicated on the itemized points list.

B. Components shall be arranged on graphic as installed in the field.

C. Include each graphic point listed in the itemized points list using real time data.

D. Provide a graphic representation of the following:

1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.
3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.
5. Show the location of each thermostat on the floor plan.
6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.

E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:

1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, and boilers, as a minimum.
4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.

F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:

1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

3.03 CONDUIT AND BOXES INSTALLATION

A. Conduit and Box Installation: Refer to Electrical Section 26 0533 for execution and installation.

B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 26 0553 for raceway and box identification installation.

C. Outlet Box Schedule: Thermostat/temperature sensor:

1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.

2. Other Conditions: Refer to Electrical Section 26 0533 for requirements.

3.04 WIRE AND CABLE INSTALLATION

A. Wire and Cable Installation: Refer to Electrical Section 26 0513 for execution and installation.

B. Field Quality Control:

1. Inspect wire and cable for physical damage and proper connection.

2. Torque test conductor connections and terminations to manufacturer's recommended values.

3. Perform continuity test on all conductors.

4. Protection of cable from foreign materials:

a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

C. Installation Schedule:

1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

3.05 FMCS INSTALLATION

A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.

B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

3.06 COMMISSIONING

A. Upon completion of the installation, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the FMCS system operation.

C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25% spare capacity for future expansion.

D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.07 PREPARATION FOR BALANCING

A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).

B. Check the calibration and setpoints of all controllers.

C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.

D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.

E. Verify the operation of all interlock systems.

3.08 TEST AND BALANCE COORDINATION

A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.

C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.

D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

3.09 DEMONSTRATION AND ACCEPTANCE

A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

3.10 TRAINING

A. On-Site:

1. After completion of commissioning, the manufacturer shall provide 6 hours of training for 4 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

B. Day-to-Day Operations - Training Description:
   1. Proficiently operate the system.
   2. Understand control system architecture and configuration.
   3. Understand FMCS systems components.
   4. Understand system operation, including FMCS system control and optimizing routines (algorithms).
   5. Operate the workstation and peripherals.
   6. Log-on and off the system.
   7. Access graphics, point reports, and logs.
   8. Adjust and change system setpoints, time schedules, and holiday schedules.
   9. Recognize malfunctions of the system by observation of the printed copy and graphic visual signals.
   10. Understand system drawings and Operation and Maintenance manual.
   11. Understand the job layout and location of control components.
   12. Access data from FMCS controllers and ASCs.
   13. Operate portable operator's terminals.

C. Provide course outline and materials in accordance with the "SUBMITTALS" article in Part 1 of this section. The instructor(s) shall provide one copy of training material per student.

3.11 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.

F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.

END OF SECTION

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SECTION 23 0913
INSTRUMENTATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Thermometers.

B. Static and Differential Airflow Pressure Gauges.

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include list that indicates use, operating range, total range and location for manufactured components.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Dial Type:

1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
3. Stem lengths as required for application with minimum insertion of 2-1/2".
4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.
5. Manufacturer:
   a. Ashcroft
   b. Marsh
   c. Marshalltown
   d. Miljoco
   e. Tel-Tru
   f. Trerice
   g. U.S. Gauge
   h. Weiss
   i. Weksler, Wika.

B. Select scales to cover expected range of temperatures.

2.02 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES

A. Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.

B. Accuracy shall be ± 3% of full scale maximum throughout entire range at 70°F.

C. Provide mounting brackets, probes, and shutoff valves required for proper installation.

D. The range and service shall be as required for application or as noted on the drawings.

E. Manufacturers:

1. Dwyer Magnehelic Series 2000
2. Marshalltown Instrument Series 85C.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:

1. Install per manufacturer's instructions.
2. Coil and conceal excess capillary on remote element instruments.
3. Install gauges and thermometers in locations where they are easily read from normal operating level.
4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

B. Thermometers:

1. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.
2. Locate duct thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

END OF SECTION

SECTION 23 2300
REFRIGERATION PIPING AND SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping and Pipe Fittings
B. Moisture and Liquid Indicators
C. Check Valves
D. Pressure Relief Valves
E. Filter-Driers
F. Suction Filters
G. Solenoid Valves
H. Expansion Valves
I. Receivers
J. Suction Accumulators

1.02 QUALITY ASSURANCE

A. Remanufactured specialties are not acceptable.

1.03 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500.
B. Submit layout of entire piping system including equipment, critical dimensions, and all pipe sizes, traps, valves, and accessories. Layout shall be a custom drawing for this job, not a standard detail. The refrigeration equipment supplier shall stamp the approval on layout drawings.
C. Submit product data for specialties, including manufacturers catalog information.
D. Submit manufacturer's installation instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labels in place.
B. Protect piping and specialties from entry of foreign material by leaving caps and plugs in place until installation.

PART 2 - PRODUCTS

2.01 PIPING

A. Design Pressure: 450 psig.
    1. Maximum Design Temperature: 250°F.
B. Piping - 4" and under; Brazed Joint:
    1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
    2. Joints: Brazed with silver solder.
    3. Fittings: Wrought copper solder joint, ANSI B16.22.
    4. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.
C. Piping - 1-3/8" and Under; Dual Concentric Crimp Mechanical Press Connection (Contractor's Option):
    1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
    2. Joints: Dual concentric crimp band mechanical press connection.

3. Fittings: Refrigerant Grade Copper in accordance with ASTM B75 or ASTM B743 with embedded HNBR O-ring.
4. Manufacturers:
    a. Rapid Locking System (RLS)
    b. Conex Banninger
    c. Parker Hannifin
    d. MaxiPro ACR
    e. Nibco ACR Press

D. Piping - 1-3/8" and Under; Mechanically Attached, Axially Swaged Compression Connection (Contractor's Option):
1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
2. Joints: Mechanically attached connector, axially swaged compression connection.
3. Fittings: Refrigerant grade copper in accordance with ASTM B75 or ASTM B743. Brass body with two stabilization inserts in accordance with ASTM B15/B16M. Two steel rings in accordance with ASTM A108-13; anerobic adhesive sealant.
4. Manufacturers:
    a. VULKAN Lokring

2.02 MOISTURE AND LIQUID INDICATORS

A. UL listed, with copper, brass, or copper-plated steel body, flared or solder ends, extended fittings in units up to at least 1-1/8" to allow brazing without removing the cartridge, sight glass, color coded paper moisture indicator that is replaceable without breaking piping connections for units up to 1-1/8" size, and plastic cap; maximum working pressure of 500 psi, and maximum temperature of 200°F.
1. Manufacturers:
    a. Sporlan
    b. Henry Valve Company
    c. Alco Valve

2.03 VALVES

A. BA-14: Refrigerant Ball Valve: 3/8" thru 3-1/8", 500 psi, -40°F to +300°F, full-port up to 2-1/8" size, blow-out proof, PTFE seals, brass ball with equalizing orifice, visible position indication, seal cap, extended copper connections, replaceable stem seals, compatible with all CFC, HCFC, and HFC refrigerants.
1. Manufacturers:
    a. Henry Valve Company
    b. Superior Valve
    c. Alco Valve

2.04 CHECK VALVES

A. CK-10: 1/4" thru 3-5/8", 500 psi, globe or angle pattern, brazed, brass body, cleaned-dried-plugged and tagged at factory for refrigerant service.
1. Manufacturers:
    a. Henry Valve Company
    b. Mueller
    c. Wolf-Linde

2.05 PRESSURE RELIEF VALVES

A. RV-5: Straight Thru or Angle Type: Brass body and disc, Teflon seat, factory sealed and stamped with ASME UV and National Board Certification NB; selected to ANSI/ASHRAE 15.

2.06 FILTER-DRIERS

A. Replaceable Cartridge Angle Type: ANSI/AHRI 710, UL listed, brass or epoxy-coated steel shell, molded desiccant high-water capacity filter core(s); maximum working pressure of 500 psi; maximum temperature of 275°F; maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

B. Permanent Straight Thru Type: ANSI/AHRI 710, UL listed, steel shell with molded desiccant filter core, maximum working pressure of 500 psi, maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

2.07 SUCTION FILTERS

A. Replaceable Cartridge Angle Type: UL listed for 500 psi up to 2-18" size, and 400 psi for larger sizes, steel shell that passes 1000-hour salt spray test with copper fittings, replaceable pleated filter element(s); maximum pressure drops of 3 psi with R410a or 2 psi with R134a at system flow rate, capable of accepting molded desiccant core for cleanup after compressor burnout, access valve in the removable end plate. Install with side refrigerant inlet.

2.08 SOLENOID VALVES

A. Valve: AHRI 760; pilot operated; copper or brass body and internal parts; synthetic seat; stainless steel stem and plunger assembly; extended solder ends to permit installation without disassembly; maximum working pressure of 500 psi; normally closed. Maximum pressure drop at system flow of 5 psi for R410a and 3 psi for R134a.

B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, surge protector and color-coded lead wires, integral junction box, Class F temperature rated, ANSI/UL 429.

2.09 EXPANSION VALVES

A. Angle or Straight Thru Type: ANSI/AHRI 750; materials suitable for system refrigerant, external equalizer, adjustable super heat setting, balanced port design, suitable for horizontal or vertical installation, with replaceable capillary tube and remote sensing bulb.

B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10°F super heat. Select to avoid being undersized at full load or excessively oversized at part load.

2.10 RECEIVERS

A. All receivers shall have capacity to hold the entire refrigerant charge when 90% full at 90°F per ASHRAE 15-78.

B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 450 psi working pressure, with tappings for inlet, outlet, and relief valve or fusible plug.

C. Over 6" Internal Diameter: ANSI/AHRI 495, welded steel; ASME U or UM stamped for 400 psi, with tappings for inlet, outlet and pressure relief valve.

2.11 SUCTION ACCUMULATORS

A. All accumulators shall have capacity to hold 50% of the refrigerant charge when 90% full at 90°F per ASHRAE 15-78, pressure drop equivalent to under 0.5°F at peak capacity, a finish that survives a 500-hour salt spray test, vertical design with dip tube and screened oil inlet orifice, and a hot gas boil-out coil to evaporate liquid refrigerant.

B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 400 psi pressure rating, with tappings for inlet, outlet, and pressure relief valve or fusible plug.

C. Over 6" Internal Diameter: ANSI/AHRI 495, welded steel, ASME U or UM stamped for 450 psi, with tappings for inlet, outlet and pressure relief valve.

2.12 EXPANSION COMPENSATION

A. Assembly consisting of two flexible connectors, two copper flexible connectors, two 90° elbows, and a 180° return pipe. Unit shall be in the form of a pipe loop.

B. Connectors shall have corrugated copper hose bodies with copper braided casings.

C. Connectors shall be rated for 150 psi working pressure at 70°F.

D. Sizes 2" and smaller shall have copper sweat ends.

E. Connectors shall be suitable for 1/2" permanent misalignment.

F. Manufacturer:

1. Metraflex Type MLS

PART 3 - EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt on inside and outside before assembly.

C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories.

3.02 INSTALLATION

A. Install specialties in accordance with manufacturer's instructions.

B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.

C. Route piping in orderly manner, parallel to building structure, and maintain gradient.

D. Install piping to conserve building space and not interfere with use of space.

E. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

F. Group piping whenever practical at common elevations and locations. Slope piping 1% in direction of oil return.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

H. Provide clearance for installation of insulation and access to valves and fittings.

I. Provide access doors for concealed valves and specialties.

J. Where pipe support members are welded to structural building frame, brush clean, and apply zinc rich primer to welding.

K. Insulate piping per Section 23 0719.

L. Provide external equalizer piping on expansion valves, and locate expansion valve sensing bulb immediately downstream of evaporator on suction line. Connect distributor to expansion valve outlet.

M. Install flexible connectors parallel to the shafts of compressors.

N. Fully charge system with refrigerant after testing.

3.03 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.

B. All pipe, fittings, valves, equipment and accessories shall have factory applied identification sufficient to determine their conformance with specified requirements.

C. Exercise care at all times to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.

D. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.

E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings.

F. Cut all pipe to exact measurement and install without springing or forcing.

3.04 APPLICATION

A. Provide solenoid valves in liquid lines of systems, in oil bleeder lines to stop flow of oil and refrigerant into the suction line when system shuts down, and in hot gas bypass lines, as applicable.

B. Provide refrigerant charging valve connections.

C. Provide replaceable cartridge filter-driers, with three-valve bypass assembly and suction filters without bypass assembly.

3.05 JOINING OF PIPE

A. Brazed Joints:

1. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
2. Flux shall conform to ANSI/AWS A5.31.
3. Remove composition discs and all seals during brazing if not suitable for a minimum of 840°F or greater than the melting temperature of the brazing filler metal, whichever is greater.

B. Mechanical Press Connection:

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Examination: Upon delivery to the jobsite, examine copper tubing and fittings for debris, defects, incise marks (manufacturer's engraving on tube), holes, or cracks.
3. Fully insert tubing into the fitting and mark tubing.
4. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
5. Joint shall be pressed with a tool approved by the manufacturer.
6. Installers shall be trained by manufacturer’s personnel or representative. Provide documentation upon request.

C. Axially Swaged Connection:

1. Brass axially swaged connectors shall be installed in accordance with the manufacturer's installation instructions.
2. Installers shall be trained by a certified Vulkan LOKRING trainer. Provide proof of certification upon request.

3.06 FIELD QUALITY CONTROL

A. Test piping system with nitrogen at 300 psig for at least 8 hours without loss of pressure.

B. Comply with ASHRAE Standard 147 for refrigerant system integrity testing.

C. After pressure testing, evacuate all refrigerant piping to at least 28" of mercury for 24 hours without loss of vacuum. Ensure moisture does not enter the piping prior to and during the tests.

END OF SECTION

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SECTION 23 3100
DUCTWORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Galvanized Ductwork
B. Stainless Steel Ductwork
C. Carbon Steel Ductwork
D. Ductwork Reinforcement
E. Ductwork Sealants
F. Rectangular Ductwork
G. Round and Flat Oval Ductwork
H. Flexible Duct
I. Grease Exhaust Duct
J. Dishwasher Exhaust Duct
K. Leakage Testing
L. Ductwork Penetrations
M. Painting

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500.
B. The Architect/Engineer may require field verification of sheet metal gauges and reinforcing to verify compliance with these specifications. At the request of the Architect/Engineer, the contractor shall remove a sample of the duct for verification. The contractor shall repair as needed.
C. Duct Layout Drawings: Submit detailed duct layout drawings at 1/4" minimum scale complete with the following information:
    1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
    2. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
    3. Room names and numbers, ceiling types, and ceiling heights.
    4. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
    5. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 23 0500.
D. Duct Leakage Test Summary Report: Upon completion of the pressure test described in Part 3, the Contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

1.03 DEFINITIONS

A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.
C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.

D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

1.04 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 23 0500 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

B. Duct drawings shall be at 1/4" minimum scale complete with the following information:

1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
3. Location and size of all duct access doors.
4. Room names and numbers, ceiling types, and ceiling heights.
5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.

PART 2 - PRODUCTS

2.01 SHAPE

A. Rectangular Duct - Single Wall:

1. General Requirements:
   a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
   b. Transitions shall not exceed the angles in Figure 4-7.
2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:
   a. All ducts shall be cross-broken or beaded.
   b. Snap lock seams are not permitted.
   c. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
      1) Type 1:
         a) Description: Single wall type with 22-gauge (0.029") or heavier vanes, 3-1/4" blade spacing, and 4" to 4-1/2" radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
         b) Usage: Limited to 3,000 fpm and vane lengths 36" and under.
      2) Type 2:
         a) Description: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
         b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

3) Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):
   a) Description: Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
   b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.
4) Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.
5) Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.
6) Omitting every other vane is prohibited.

d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.

e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.

f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.

g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.

h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.

i. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.

j. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
   1) Apply sealant to all inside corners. Holes at corners are not acceptable.
   2) Manufacturers:
      a) Ductmate Industries - 25/35/45
      b) Nexus
      c) Mez
      d) WDCI
      e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

k. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
   1) Apply sealant to all inside corners. Holes at corners are not acceptable.
   2) Flanges shall be 24-gauge minimum (not 26 gauge).
   3) Manufacturers:
      a) Lockformer TDC
      b) TDF
      c) United McGill
      d) Sheet Metal Connectors
      e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

B. Round and Flat Oval Spiral Seam Ductwork - Single Wall:
1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
3. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
4. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
10. Transverse Joint Connections:
    a. Crimped joints are not permitted.
    b. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
    c. Ducts and fittings larger than 36" shall have flanged connections.
    d. Secure all joints with at least 3 sheet metal screws before sealing.
    e. Manufacturers:
       1) Slide-on Flanges:
       2) Ductmate Industries - SpiralMate

3) Accuflange
4) Sheet Metal Connectors are acceptable.

f. Manufacturers, Self-Sealing Duct Systems:
1) Lindab
2) Ward "Keating Coupling"

2.02 MATERIAL AND APPLICATION SPECIFIC

A. Galvanized Steel:
1. General Requirements:
a. Duct and reinforcement materials shall conform to ASTM A653 and A924.
b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
d. Ductwork reinforcement shall be of galvanized steel.
2. Duct Hangers and Support:
a. Ductwork supports shall be of galvanized or painted steel.
b. All fasteners shall be galvanized or cadmium plated.
c. Strap Hangers: Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel attached to the bottom of ducts with spacing as required by SMACNA.
d. Cable Hangers:
1) Aircraft cable and slip cable hangers are acceptable for ducts up to 18" diameter. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork. Manufacturers; Supports:
a) Gripple
b) Ductmate
c) Duro Dyne
d) Architect/Engineer approved
e. Integral Corner Connector Hanger: Integral hanger and corner assembly for use with TDC/TDF style duct flanges. Die stamped offset hanger connects to the flanged corner assembly. For use with aircraft cable or 1/4" or 3/8" diameter threaded rods. Tested to hold up to 1,400 lbs. Install per manufacturer’s ratings and instructions.
1) Manufacturers; Supports:
a) EZ Hanger

B. Stainless Steel Ductwork:
1. General Requirements:
a. Ductwork shall be Type 304L stainless steel, 16 gauge minimum.
b. Exposed ductwork shall have a #3 finish. Concealed ductwork may have milled finish.
c. Ductwork reinforcement shall be of stainless steel.
2. Duct Hangers and Supports:
a. Ductwork supports shall be of stainless steel. Slip cable hangers are acceptable.
1) Manufacturers, Supports:
a) Gripple
b) Ductmate

c) Duro Dyne

d) Architect/Engineer approved

b. All fasteners shall be cadmium plated or stainless steel.

C. Carbon Steel Ductwork:

1. Ductwork shall be black carbon steel. Refer to Grease Exhaust Duct below for thicknesses.

D. Grease Exhaust Duct:

1. Field Fabricated

a. Exposed ductwork shall be 16 gauge minimum, Type 304L stainless steel. Concealed ductwork may be 16 gauge black steel.

b. Concealed Ductwork:

1) Range hood/grease exhaust ducts having an area of 4 sf or less shall be 16 gauge carbon steel.

2) Range hood/Grease exhaust ducts having an area greater than 4 sf shall be 14 gauge carbon steel.

c. All joints and fittings shall be continuously welded and liquid-tight.

d. Exposed ductwork shall have a #3 finish. Concealed ductwork may have a mill finish.

e. Do not penetrate fire rated partitions, unless protected as required by applicable codes.

f. Provide pre-fabricated access doors and labels required by NFPA 96 on sides of duct at least 1.5" from bottom. Provide access at each change in direction and at maximum 20-foot intervals in horizontal ducts. Provide access at every floor for vertical ducts.

g. Install grease traps in kitchen grease and dishwasher ducts at base of all vertical risers and low points in the system.

h. Where grease ducts are 20" x 20" or larger, install access for personnel to enter duct. Duct supports must be sized to support the duct weight and an additional 800 lbs. per NFPA 96.

i. Install ducts with proper clearance to combustible and limited-combustible materials.

j. Grease exhaust duct doors shall be grease and airtight, UL 1978 listed, meet NFPA 96 standards, and all mechanical codes. Grease duct access doors can be sandwich type or with a weld-on frame, with/without hinge.

1) Manufacturer, Duct Doors:

a) Ductmate Industries "Ultimate I" or "Ultimate II" Style door

b) Approved equal

k. All grease duct access doors used must be accompanied by independent testing in conjunction with each manufacturer's respective wrap system for high temperature applications.

l. Refer to Section 23 0713 for duct insulation material and insulated access door when required to provide proper enclosure of ductwork.

E. Dishwasher Exhaust Duct:

1. Ductwork shall be 16 gauge minimum Type 304L stainless steel.

2. All joints and fittings shall be continuously welded and liquid-tight.

3. Ductwork exposed in kitchens shall have a #3 finish. Concealed ductwork may have a standard mill finish.

4. Do not penetrate fire rated partitions, unless protected as required by applicable codes.

2.03 DUCTWORK REINFORCEMENT

A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.

1. Ducts must be over 18" wide.
2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
3. Tie rods must not exceed 1/2" diameter.
4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.04 DUCTWORK SEALANTS

A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M.

2.05 FLEXIBLE DUCT

A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.

B. Flame Spread/Smoke Developed: Not over 25/50.

C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.

D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.

E. Acoustic:

1. Flexible duct shall be acoustic rated in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL. Insertion loss values noted below are for flow velocities less than 2,500 fpm. Submittals shall include insertion losses ratings per sizes and lengths listed below regardless of sizes shown on the drawings.
2. Flexible have corrosion-resistant wire helix, bonded to a nylon fabric core inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. Usage: All areas unless noted otherwise.
3. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft2*ºF*hr/Btuh. Temperature range of at least 0-180ºF. Maximum velocity of 4,000 fpm.
4. Minimum Acoustic Insertion Losses per octave band:
   a. Straight Duct:

Diameter	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	4.0	13	15	15	16	17	16
6" ø	3 ft	2.3	4.9	5.3	5.3	5.5	5.8	5.4
8" ø	6 ft	5.7	14	13	15	16	18	16
8" ø	3 ft	2.9	5.0	4.9	5.7	5.6	5.8	5.6
12" ø	6 ft	5.5	13	12	15	15	18	13
12" ø	3 ft	2.8	4.8	4.7	5.3	5.3	5.8	4.9

b. 90 degree Elbow:

Diameter	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" ø	6 ft	10	15	16	17	18	17	18
6" ø	3 ft	3.8	5.4	5.5	5.7	5.9	5.8	5.9
8" ø	6 ft	10	15	16	17	16	18	18
8" ø	3 ft	2.4	5.3	5.6	5.8	5.6	5.9	6.0
12" ø	6 ft	11	14	15	16	15	16	15
12" ø	3 ft	4.4	5.1	5.3	5.5	5.4	5.6	5.3

5. Usage:
   a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.
   b. Connections to air inlets and outlets. Do not exceed 6'-0" in length.
   c. Acceptable Manufacturers:
      1) Flexmaster USA - Type 6
      2) Thermaflex M-Ke

F. Radius Forming Elbows:
1. Flexible plastic radius forming elbow for use with flexible ducts to create 90deg elbow. One size for 6" to 16" diameter ducts. UL listed for return plenum spaces.
2. Usage: All supply air terminals with flexible ductwork connection.
3. Installation: Attach to flex duct and secure draw bands without crushing flex duct to form smooth radius elbow. Suspend radius forming elbow to structure. Install per manufacturer’s instructions.
4. Acceptable Manufacturers:
   a. Hart & Cooley - Smartflow
   b. Thermaflex - Flexflow
   c. Titus - Flexright

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide openings in ducts for thermometers and controllers.
B. Locate ducts with space around equipment for normal operation and maintenance.
C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
E. Supply ductwork shall be free of construction debris, and shall comply with Level "B" of the SMACNA Duct Cleanliness for New Construction Guidelines.
F. Repair all duct insulation and liner tears.
G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
H. Insulate terminal air box reheat coils. Seal insulation tight to form a tight vapor barrier.

I. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.

J. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.

K. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible.

L. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.

M. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

N. Kitchen Grease and Dishwasher Ductwork:

1. All kitchen grease and dishwasher ductwork shall be installed with a continuous slope and grease tight welds on all seams and joints.

3.02 DUCTWORK APPLICATION SCHEDULE

A. General:

1. Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual
2. Insulation:
   a. Refer to Section 23 0713 for insulation types.
   b. Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).

B. AHU-1 Supply Duct from Fan to Terminal Air Boxes - Single Wall:

1. Shape:
   a. Rectangular Duct - Single Wall
   b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: +3"
4. Seal Class: A
5. Insulation:
   a. 1-1/2" thick Type A (R=4.5)
6. Additional Requirements: None

C. Supply Duct from Terminal Air Boxes to Outlets:

1. Shape:
   a. Rectangular Duct - Single Wall
   b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
2. Material: Galvanized Steel
3. Pressure Class: +2"
4. Seal Class: A
5. Insulation:
   a. 1-1/2" thick Type A (R=4.5)
6. Additional Requirements: None

D. DOAS-1 from Fan to Outlet:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: +2"
   4. Seal Class: A
   5. Insulation:
      a. 1-1/2" thick Type A (R=4.5)
   6. Additional Requirements: None

E. Return Duct:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation:
      a. None
   6. Additional Requirements: None

F. General Exhaust Duct:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation: None
   6. Additional Requirements: None

G. Combustion Air Duct:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -1"
   4. Seal Class: A
   5. ASHRAE 90.1-2019 and IECC-2021
      a. Insulation: 1 1/2" thick Type B (R=6.0)
   6. Additional Requirements: None

H. Relief/Exhaust Air Duct from Fan to Exhaust Outlet:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: +2"
   4. Seal Class: A
   5. Insulation:
      a. 1-1/2" thick Type A (R=4.5)

I. Grease Exhaust Duct:
   1. Shape: Refer to "Grease Exhaust Duct"
   2. Material: Field Fabricated
   3. Pressure Class: -3"
   4. Seal Class: A
   5. Insulation: Type F.

J. Dishwasher Exhaust Duct:
   1. Shape: Refer to "Dishwasher Exhaust Duct"
   2. Material: Dishwasher Exhaust Duct
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation: 1-1/2" thick Type A (R=4.5)

K. Outside Air Intake from Louver to Heating Coil:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: -2"
   4. Seal Class: A
   5. Insulation: 1 1/2" thick Type B (R=6.0)

L. Relief Air Louver to Backdraft Damper:
   1. Shape:
      a. Rectangular Duct - Single Wall
      b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
   2. Material: Galvanized Steel
   3. Pressure Class: +2"
   4. Seal Class: A
   5. Insulation:
      a. 1 1/2" thick Type B (R=6.0)

M. Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.):
   1. Insulation:
      a. 1-1/2" thick Type A (R=4.5)

3.03 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

3.04 TESTING

A. Interior Duct - Less than 3" WG (positive or negative):

1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

B. Interior Duct - 3" WG and Above (positive or negative):

1. Duct system shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.
2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
3. Seal ducts to bring the air leakage into compliance.
4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.

C. Test Procedure:

1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
    a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.
    b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
    c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
    d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
    e. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.

f. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.

g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.

i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

D. Grease Exhaust Duct:

1. A light test shall be performed by passing a lamp having a power rating of not less than 100 watts through the entire section of ductwork to be tested. The lamp shall be open to emit light equally in all four directions.

2. Testing of the entire exhaust duct system including the hood-to-duct connection shall be performed. Ductwork shall be permitted to be tested in sections provided every joint is tested.

3. Leakage testing shall occur prior to use or concealment of the duct system. Ducts shall be considered concealed where installed in shafts or covered by insulation or wrap that prevents ductwork from being visibly inspected on all sides. The test shall be performed in the presence of the code official.

3.05 DUCTWORK PENETRATIONS

A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.

B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.

C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

3.06 PAINTING

A. Paint interior of ducts black within twice the largest duct dimension of inlets and outlets where interior of duct is visible.

END OF SECTION

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SECTION 23 3300
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Manual Volume Dampers.

B. Fabric Connectors.

C. Duct Access Doors.

D. Duct Test Holes.

E. Duct Silencers.

F. Temperature Control Dampers.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500.

B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.01 MANUAL VOLUME DAMPERS

A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.

B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.

C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.

E. Provide locking quadrant regulators on single and multi-blade dampers.

F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

2.02 FABRIC CONNECTORS

A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.

B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.

C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.

D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.

E. All corners shall be folded, sealed with mastic and stapled on 1" centers.

F. Fabric connectors shall not be painted.

G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.

H. Materials:

1. Durodyne MFN-4-100
2. Vent Fabrics, Inc.
3. "Ventglas"
4. Proflex PFC3NGA

2.03 DUCT ACCESS DOORS

A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.

B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.

C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

D. Access doors with sheet metal screw fasteners are not acceptable.

E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.

F. Provide duct access door in all horizontal return ductwork at 20 foot intervals per NFPA 90A.

2.04 GREASE DUCT ACCESS DOORS

A. Provide pre-fabricated and pre-insulated duct access doors by the same manufacturer as the fire resistive duct wrap.

2.05 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

2.06 DUCT SILENCERS

A. Straight Silencer

1. All silencers shall be factory fabricated by the same manufacturer, except that 'No-Loss" silencers (thicker than normal double-wall ducts) may be Contractor fabricated.
2. Duct silencers shall have length, air pressure drop, and self-generated sound ratings not to exceed the values scheduled on the drawings. Dynamic insertion ratings shall not be less than those scheduled on the drawings. Silencer inlet and outlet dimensions must match the sizes on the drawings. Transitions are not acceptable unless shown on the drawings.
3. All silencer ratings shall be determined in accordance with the ASTM E477-06a test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.
4. Silencers shall be constructed of galvanized steel, have 26 gauge minimum perforated interior (22 gauge for transitional silencers), be able to withstand 8" of positive and 4" of negative pressure, and shall have inorganic, bacteria, and fungus resistant glass fiber filler with not less than 5% compression. Silencers shall meet SMACNA standards for the duct pressure class specified.
5. Fiberglass cloth or other scheduled liners shall completely separate the media from the airstream.
6. Silencers shall not exceed 25/50 flame spread/smoke developed per ASTM E84, NFPA 255, or UL 723.
7. Manufacturers:
    a. Vibro-Acoustics
    b. VAW
    c. United McGill
    d. Semco
    e. Ruskin Sound Control (Rink)
    f. Dynasonics
    g. Price
    h. All silencers shall be by the same manufacturer

2.07 DUCTWORK ACCESSORY SEALANTS

A. Ductwork accessory sealants and adhesives shall conform to Section 23 3100.

2.08 CONTROL DAMPERS AND DAMPER ACTUATORS

A. Control dampers and damper actuators shall be furnished by the Temperature Control Contractor (Section 23 0900) and shall be installed by this Contractor.

B. Coordinate exact sizes, locations, and installation requirements with the Temperature Control Contractor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.
2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Grease duct access doors shall be installed per approvals from manufacturer's ICC-ES Evaluation Report.
6. Provide duct test holes where indicated and as required for testing and balancing purposes.

B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing.
2. Provide ceiling access doors for manual volume dampers.

C. Control Dampers and Damper Actuators:

1. Install control dampers and damper actuators in accordance with manufacturer's instructions and in coordination with the Temperature Control Contractor.
2. Seal around damper frame inside ductwork with duct sealant to prevent bypass around damper.
3. Provide duct access door at each control damper.

END OF SECTION

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SECTION 23 3423
POWER VENTILATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Roof Exhaust Fan.

B. Rooftop Fan Curbs.

1.02 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

B. Sound Ratings: AMCA 301, tested to AMCA 300.

C. Fabrication: Conform to AMCA 99.

D. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.

B. Submit manufacturer's installation instructions.

C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.04 EXTRA STOCK

A. Provide one (1) extra belt set for each fan unit.

PART 2 - PRODUCTS

2.01 ROOFTOP EXHAUST FAN - BELT DRIVEN

A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.

B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.

C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.

E. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.

F. Motor mounted outside of air stream and ventilated with outside air. Motor not less than 1/3 HP.

G. Aluminum or brass bird screen. Plastic mesh will not be allowed.

H. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.

I. Furnish normally closed, electric motorized damper. Provide step down transformer if required. Install and wire damper to open when fan runs.

J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods. Leakage shall not exceed 4 cfm/sq.ft @1" SP (or shall be AMCA Class 1 certified).

K. Mill aluminum finish.

L. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.

M. Manufacturers:
1. Aerovent "FACX"
2. Cook "ACE-B"
3. Greenheck "GB"
4. Carnes "VEB"
5. PennBarry DX
6. ACME PV
7. ILG CRB
8. Twin City BCRD
9. York

2.02 ROOFTOP EXHAUST FAN - VERTICAL DISCHARGE - BELT DRIVEN

A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backwards inclined blades, statically and dynamically balanced.

B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.

C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

D. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.

E. Motor mounted outside of air stream and ventilated with outside air. Motor not less than 1/3 HP.

F. Aluminum or brass bird screen. Plastic mesh will not be allowed. Do not provide/install for kitchen/grease hood applications.

G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.

H. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.

I. Include ventilated curb cap and hinged base with restraining means.

J. Furnish normally closed, electric motorized damper. Furnish step down transformer if required. Install and wire damper to open when fan runs. Do not provide/install for kitchen/grease hood applications.

K. All fans serving range hoods shall have extended shrouds to discharge at least 40" above roof and built-in grease trough with drain.

L. Mill aluminum finish.

M. Manufacturers:
1. ACME
2. Cook
3. Greenheck
4. PennBarry
5. Twin City
6. Jenco
7. Soler-Palau
8. York

2.03 ROOFTOP FAN CURBS

A. Furnish and install prefabricated roof curbs for all rooftop fans.

B. Size curb to match the curb cap of fan.

C. Roof Mounting Curb: Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

D. Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer.

E. 14-gauge aluminum construction.

F. Curb without cant.

G. Manufacturers:

1. Same manufacturer as the fan
2. Pate
3. RPS
4. Thy

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated lag screws to roof curb.

C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.

D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION

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SECTION 23 3600
AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Single Duct Variable Air Volume Terminal Box.

B. Fan Powered Variable Air Volume Terminal Box.

1.02 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 0500.

B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.

C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.

D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Submit manufacturer's installation instructions.

1.03 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.

C. Include directions for resetting constant volume regulators.

PART 2 - PRODUCTS

2.01 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

A. All units shall have noise data certified in accordance with AHRI Standard 885-98 with 5/8" 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Acoustical considerations shall take priority over sizes noted in schedule. It is the manufacturer's responsibility to increase inlet size to meet acoustic levels scheduled.

2.02 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Minimum 22 gauge galvanized steel.

1. Fully insulated with 3/4" elastomeric closed cell insulation liner. Insulation shall be UL listed and meet NFPA 90A requirements.

a. Usage: All supply air systems.

B. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

C. Inlet Flow Sensor: Provide "cross" or "ring " style velocity and static sensor at inlet to box for use by unit controller.

D. Damper Operators: Electronic. Furnish all mounting brackets, relays, and linkages. Provided and installed by the TCC in the field.

E. Electronic Volume Regulator/Controller: Provided and installed by the TCC in the field. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Set boxes for maximum and minimum settings shown on the drawings.

F. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cutout primary safety device, manual reset thermal cutout secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing, SCR control. Capacity and voltage shall be as scheduled on the drawings.

G. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.

H. Refer to control diagrams and notes on control drawings for complete sequence of control.

I. Manufacturers:

1. Carrier
2. Titus
3. Trane
4. Krueger
5. Carnes
6. E.H. Price
7. Tuttle & Bailey
8. Nailor
9. Enviro-Tec
10. Johnson Controls Inc.
11. Metalaire.
12. Anemostat.

2.03 FAN POWERED VARIABLE AIR VOLUME TERMINAL BOX

A. Casing: Parallel minimum 22 gauge galvanized steel. Factory mounted access panel to provide access to air valve and fan.

B. Insulation:

1. Fully insulated with 3/4" elastomeric closed cell insulation liner. Insulation shall be UL listed and meet NFPA 90A requirements.

a. Usage: All supply air systems.

C. Fan: FC style, galvanized steel fan wheel. Fan housing shall be 22 gauge steel and fan board shall be 18 gauge steel. Motors shall be permanently lubricated, direct drive, permanent split capacitor type motor. Maximum motor temperature rise on all speeds of 50°F. Fan motor voltage shall be as scheduled on the drawings.

D. Damper Blades: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.

E. Inlet Flow Sensor: Provide "cross" or "ring" style velocity and static sensor at inlet to box for use by unit controller.

F. Damper Operators: Electronic. Furnish all mounting brackets, relays, and linkages. Provided and installed by the TCC in the field.

G. Electronic Volume Regulator/Controller: Provided and installed by the TCC in the field. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Set boxes for maximum and minimum settings shown on the drawings.

H. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cut-out primary safety device, manual reset thermal cut-out secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing, **SCR** control. Capacity and voltage shall be as scheduled on the drawings.

I. Fan Inlet: Flanged inlet for field installed ducted return and filter.

J. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.

K. Refer to control diagrams and notes on control drawings for complete sequence of control.

L. Manufacturers:

1. Carrier
2. Titus
3. Trane
4. Krueger
5. Carnes
6. E.H. Price
7. Nailor
8. Enviro-Tec
9. Johnson Controls Inc.
10. Anemostat.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.

C. Provide ceiling access doors or locate units above easily removable ceiling components.

D. Support units individually from structure. Do not support from adjacent ductwork.

E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.

F. Comb fins on coils to repair bent fins.

3.02 ADJUSTING

A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION

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SECTION 23 3700
AIR INLETS AND OUTLETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Grilles And Registers.

B. Architectural Square Panel Diffusers.

C. Louvers.

D. Roof Hoods.

E. Roof Curbs.

F. Goosenecks.

1.02 QUALITY ASSURANCE

A. Test and rate performance of air inlets and outlets per ASHRAE 70.

B. Test and rate performance of louvers per AMCA 500L-99.

C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.03 SUBMITTALS

A. Submit product data under provisions of Section 23 0500.

B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.

C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.

D. Submit manufacturer's installation instructions.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

B. Conform to ASHRAE 90.1.

PART 2 - PRODUCTS

2.01 AIR TERMINALS - GRILLES AND REGISTERS

A. Reference to a grille means an air supply, exhaust or transfer device without a damper.

B. Reference to a register means an air supply, exhaust or transfer device with a damper.

C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.

D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

E. The capacity and size of the unit shall be as shown on the drawings.

F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect. .

G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.

H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.

I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.

J. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.

K. Manufacturers:

1. Tuttle & Bailey
2. Titus
3. Price
4. Nailor
5. Carnes
6. Metalaire
7. Krueger
8. Anemostat
9. Raymon Donco

2.02 AIR TERMINALS - ARCHITECTURAL SQUARE PANEL DIFFUSERS

A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.

B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.

C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

D. The capacity and size of the unit shall be as shown on the drawings.

E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10^{-12} watts with a 10 dB room effect.

F. Diffusers shall be architectural solid square panel and flush with ceiling.

G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge aluminum with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.

H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).

I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.

J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)

K. Manufacturers:

1. Tuttle & Bailey
2. Titus
3. Price
4. Nailor
5. Carnes
6. Metalaire
7. Krueger
8. Anemostat
9. Raymon Donco

2.03 LOUVERS - FIXED - ALUMINUM

A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.

B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.

C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.

D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.

E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.

F. Contractor shall provide the Division 3 Contractor with the correct sizes and locations of all louvers required in masonry walls.

G. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.

H. Louvers shall be suitable for duct connection.

I. Manufacturers:

1. Air Flow - "EA-403"
2. Arrow - "EA-415-D"
3. American Warming & Ventilating - "LE-21"
4. Construction Specialties - "A4097"
5. Dowco - "DBE-4"
6. Louvers & Dampers, Inc. - "IL-23"
7. Ruskin - "ELF375DX"
8. Vent Products - "2760"
9. Greenheck - ESD "403"
10. Pottorff - EFD
11. United Enertech FL-D-4
12. Anemostat
13. Arrow

2.04 ROOF HOODS

A. Hoods shall be constructed of roll formed, interlocking aluminum panels. Vertical end panels are fully locked into hood.

B. Top of curb to hood inlet shall be minimum of 5".

C. Curb cap shall be of 14 gauge formed aluminum with mitered corners continuously heliarc-welded. Hood shall be of the same material and cross-broken for added strength.

D. Hoods shall be furnished with aluminum bird screen.

E. Hood and throat shall be reinforced with extruded aluminum angle and have a minimum snow load rating of 30 lbs. per square foot.

F. Size, cfm, finish and pressure drop for hoods shall be as scheduled on the drawings.

G. Inlet area shall be minimum 150% of throat area for intake hoods. Outlet area shall be minimum 125% of throat area for exhaust hoods and relief vents.

H. Hoods shall be furnished with 12" high curb (above top of roof) and be of the size and type as shown on the drawings.

I. Hood shall be furnished with motorized damper unless otherwise noted on the drawings.

J. Manufacturers:
1. Ammerman
2. Carnes
3. Cook
4. Greenheck
5. ILG
6. Jenco Fan
7. PennBarry
8. Twin City Fan & Blower
9. York
10. United Enertech GEV-GIV

2.05 ROOF CURBS

A. Furnish and install, where shown on the drawings, prefabricated roof curbs for all rooftop hood openings.

B. Roof Mounting Curb: Curb shall be sized to match curb cap of the hood. Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

C. Curbs shall be unitized construction, 18 gauge galvanized steel, with continuous arc welded corner seams, insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board and damper support angle.

D. Curb without cant - suitable for use with membrane type roof.

E. Manufacturers:
1. Same manufacturer as the equipment it serves or Pate, RPS, or Thy.

2.06 GOOSENECKS

A. Fabricate in accordance with SMACNA Duct Construction Standards of minimum 18 gauge galvanized steel.

B. Mount on minimum 12 inch high curb base.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:
1. Install items in accordance with manufacturers' instructions.
2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
3. Install diffusers to ductwork with air tight connections.
4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
5. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.

B. Volume Damper:
1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

C. Roof Hood:
1. If manufacturer has no recommendations, secure roof hoods to curbs with 1/4" lag bolts on 8" maximum centers.

D. Maintaining Duct Cleanliness:

1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 23 0500.

END OF SECTION

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SECTION 23 4000
AIR CLEANING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Filters and Filter Media.

B. Filter Gauges.

1.02 QUALITY ASSURANCE

A. Filter media shall be tested under ANSI/UL 900 and labeled.

B. Provide all filters and filter banks by one manufacturer.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Include data on media, performance, assembly and frames.

1.04 EXTRA STOCK

A. Provide a total of three (3) sets of filters for all units.

1. Provide clean filters in all units at time of installation.
2. Provide clean filters in all units at project final completion after all interior finishes are complete.
3. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

PART 2 - PRODUCTS

2.01 MERV 4 (FIBERGLASS THROWAWAY) - TYPE B

A. 1" thick fiberglass media with rigid frame and grille, minimum 20% efficiency per ASHRAE Standard 52.1 or MERV 4 per ASHRAE 52.2.

2.02 MERV 8 (MEDIUM EFFICIENCY) - DISPOSABLE - TYPE D

A. Non-woven cotton fabric, pleated media, disposable type with welded wire grid support bonded to the filter media.

B. Heavy duty, paper board frame with diagonal support members bonded to inlet and exit sides of each pleat. Bond frame to media periphery to eliminate air bypass.

C. 2" thick media with at least 4.6 square feet of media per square foot of face area. Maximum initial resistance of 0.30" WGat 500 fpm face velocity.

D. 25-30% efficiency and 90-92% arrestance per ASHRAE 52.1 or MERV 8 per ASHRAE 52.2.

2.03 MERV 13 (85% EFFICIENT) RIGID FILTER - DISPOSABLE - TYPE F

A. Pleated, rigid, disposable type with high density, fine fiberglass laminated to non-woven synthetic backing. Welded wire grid media support bonded to the filter media. Galvanized steel enclosing frame bonded to media periphery to eliminate air bypass.

B. Maximum 12" thick cartridges with at least 14.5 square feet of media per square foot of face area.

C. 80-85% efficiency and 98% arrestance per ASHRAE 52.1 or MERV 13 per ASHRAE 52.2. Maximum 0.60" WG initial resistance at 500 fpm face velocity.

D. Manufacturers:

1. Camfil
2. Flanders
3. American Air Filter

2.04 FILTER GAUGES

A. Differential Pressure Gauge: Diaphragm actuated, nominal 3" round dial, glass filled nylon housing, polycarbonate lens, zero adjustment, 0-2" W.G. range, 5% of full scale accuracy.

B. Accessories: Static pressure tips with integral compression fittings and 1/8" NPT plastic tubing.

C. Manufacturers:

1. Dwyer "Minihelic II" 2-5000
2. Marshalltown Instrument "Series 85C"

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all products per manufacturers' instructions.

B. Seal filter media to prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan systems without filters.

D. Install static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and calibrate. Every filter bank, including packaged units, shall have a filter gauge.

END OF SECTION

SECTION 23 6213
AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Condensing Unit Package.

B. Charge of Refrigerant and Oil.

C. Controls and Control Connections.

D. Refrigerant Circuit.

E. Motor Starters.

F. Electrical Power Connections.

1.02 SUBMITTALS

A. Submit shop drawings per Section 23 0500 indicating components, assembly, dimensions, weights and loadings, required clearances, location and size of field connections, rated capacities, and electrical nameplate data. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system. Piping diagrams shall apply specifically to this job. Include description of capacity control logic and interface with building control system.

B. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

C. Submit operation and maintenance data including start-up instructions, maintenance instructions, parts lists, controls, and accessories.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage. Protect coils.

1.04 WARRANTY

A. Provide a one-year parts and labor warranty. Compressors shall have an additional four year warranty covering all material and labor costs for compressor repair or replacement at the Owner's option.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. Units: Self-contained, packaged, factory assembled and wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, and screens.

B. Construction and Ratings: In accordance with AHRI 210/240 and ANSI/UL 207 and 303. Testing shall be in accordance with ASHRAE 14.

C. Performance Ratings: EER and COP meeting ANSI/ASHRAE 90.1.

2.02 CASING

A. House components in welded steel frame with galvanized steel panels with painted finish meeting ASTM B117 salt spray test standard.

B. Mount starters, disconnects, and controls in weatherproof panel with full opening access doors.

C. Provide gasketed removable access doors or panels with quick fasteners.

2.03 CONDENSER COILS

A. Aluminum fins mechanically bonded to seamless copper tubing. Provide 12°F of refrigerant subcooling at design conditions.

B. Provide hail guards on all condenser coils.

2.04 CONDENSER FANS AND MOTORS

A. Vertical discharge direct drive propeller type condenser fans with fan guards.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in thermal overload protection.

C. Dynamically and statically balanced fans.

D. Separate motors for each fan.

2.05 COMPRESSORS

A. Construction: Semi-hermetic or hermetic scroll type with suction and discharge valves.

B. Mounting: Dynamically balance rotating parts and mount on vibration isolators.

C. Lubrication System: Oil pump with oil charging valve, oil level sight glass, oil filter, and magnetic plug or strainer.

D. Capacity Reduction Equipment: Multiple compressors, and/or multi-speed or variable-speed compressors.

E. Motor: Suction gas cooled with electronic sensor and winding over temperature protection.

F. Crankcase Heater: Evaporates refrigerant in crankcase during shutdown.

G. Suitable for operating on voltages plus or minus 15% of nameplate ratings.

2.06 REFRIGERANT CIRCUIT

A. Refrigerant may be new or reclaimed, and shall meet ARI-700-2004 Standard for Refrigerant Purity.

B. Provide each unit with the number of refrigerant circuits needed to provide the scheduled unloading and properly transport oil.

C. Provide the following for each refrigerant circuit:

1. Replaceable core type filter dryer.
2. Liquid line sight glass and moisture indicator.
3. Thermal expansion valve.
4. Insulated suction line.
5. Suction and liquid line service valves.
6. Schraeder valve.
7. Condenser pressure relief valve.
8. Suction filter.
9. Liquid line solenoid valve.

D. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

2.07 CONTROLS

A. On unit, mount NEMA 4 steel control panel containing power and control wiring, factory wired with single point power connection.

B. For each compressor, provide across-the-line starter, factory wired non-fused disconnects, non-recycling compressor overload, starter relay, and control power transformer. For each condenser fan, provide across-the-line starter with starter relay.

C. Provide the following safety controls arranged so operating any one will stop unit:

1. Manual reset high discharge pressure switch for each compressor.
2. Automatic reset low suction pressure switch for each compressor.
3. Manual reset oil pressure switch.

D. Provide the following operating controls:

1. Timer(s) that prevents compressor short cycling.
2. Low ambient temperature (as scheduled) thermostat to lock out compressor.
3. If discharge or return air control is provided with the unit, provide adjustable time delay between stages of operation. All units shall be compatible with direct control of staging by DDC systems. Suction pressure control of staging is not acceptable.
4. Pump down control that activates when the lead compressor of each circuit stops.
5. Hot gas bypass sized for minimum compressor loading, or "Frostat" control. If hot gas is used, the pipe with modulating flow (hot gas or suction) must pitch continuously downward in the direction of flow.
6. Thermostat to cycle fan motors in response to head pressure.
7. Head pressure controlled damper or variable speed fan control on first stage condenser fan. Rated for starting at 0°F.

2.08 MANUFACTURERS

A. Trane

B. York

C. Daikin

D. Carrier

E. Units shall be of the same manufacturer as the evaporator coil.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Comb all condenser coils to repair bent fins.

C. Install on vibration isolators as scheduled on the drawings or in Section 23 0548.

D. Connect to refrigeration piping and evaporators.

3.02 MANUFACTURER'S FIELD SERVICES

A. Provide initial start-up by factory authorized service representatives. Adjust units to provide proper superheat.

B. Supply initial charge of refrigerant and oil for each refrigerant circuit. Replace losses of refrigerant and oil during the warranty period.

END OF SECTION

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SECTION 23 7313
INDOOR MODULAR AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Modular Indoor Handling Units.

1.02 QUALITY ASSURANCE

A. AHU Unit: Manufacturer specializing in design and manufacturing of the products specified in this section.

B. Fabrication: Conform to AMCA 99 and AHRI 430.

C. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.

D. Sound Ratings: Tested to AMCA 300.

E. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

F. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.

G. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.

H. Unit shall contain only UL listed components.

I. Conform to ASHRAE 90.1.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.

1. Product Data

   a. Include data on all fans and accessories. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.

   b. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops

   c. Submit sound power level data for both fan outlet and casing radiation at rated capacity.

   d. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions

   e. Submit manufacturer's data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.

   f. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.

B. Submit manufacturer's installation instructions.

C. All base bid pricing shall be based on the drawings, schedules and this specification

1. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices on the bid form. These voluntary prices will not be used in determining the low bidder.

2. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Architect/Engineer prior to the award of the air handling unit bid and before the submittal process begins.

D. Any exceptions to the specifications must be clearly noted to the Architect/Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.

E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

F. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.

G. Piezometer Flow Coefficients: Submittals for fans shall clearly indicate the size and associated flow coefficient for each fan included in the submittal as it relates to the piezometric airflow measuring system. Provide instructions indicating how the flow coefficient can be used in calculating fan airflow using the fan manufacturer provided empirically derived formulas for calculating airflow. Include recommended differential pressure controller ΔP range (inches w.g based on scheduled maximum airflows.

1.04 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.

B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.06 WARRANTY

A. Provide a manufacturer's 1-year parts and labor warranty against defects in material and workmanship.

1.07 GENERAL DESCRIPTION

A. Unit Location:

1. The air handling unit (AHU-1) is a variable air volume modular unit, located in a non-conditioned mechanical penthouse.
2. The dedicated outside air handling unit (DOAS-1) is a variable air volume modulate unit, located in a non-condition mechanical penthouse.
3. The unit will be set on a concrete housekeeping pad by the Contractor.

B. Building Type: The building is a steel structure with a cast-in-place concrete floor system on steel wide flange beams. The building exterior is a precast wall panel system. (AHU-1, DOAS-1)

C. Unit Description:

1. The unit shall contain all the components described in these specifications and shown on the drawings and schedules.
2. Refer to air handling unit drawings and schedules for additional information

PART 2 - PRODUCTS

2.01 MODULAR INDOOR AIR HANDLING UNITS

A. Manufacturers

1. Trane - Performance Climate Changer.
2. Daikin - Vision.
3. Carrier - 39 Series.
4. JCI/York - Solutions.
5. Air Flow Equipment - Wolverine.
6. Ventrol - ITF Indoor Unit.
7. Temtrol - Series ITF.

B. Housing:

1. Minimum 18 gauge G60 galvanized steel exterior panels reinforced and braced with galvanized steel framework.
2. Removable access panels for coil and fan removal.
3. Unit shall be double wall insulated constructed panel. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel. Cover all portions of the interior of the unit exposed to the airstream with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor is responsible for covering exposed insulation with galvanized sheet metal. The minimum R-value of the panel assemblies shall be 8.
4. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
5. Units shall be draw-thru or blow-thru as noted on the drawings and shall not exceed the overall dimensions.

C. Doors:

1. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls.
2. Doors shall contain a continuous neoprene bulb type gasket.
3. Each door shall contain a double pane tempered, reinforced or safety glass window.
4. Each door shall have a minimum of two (2) high compression type latches, operable from both sides.
5. Unit shall have full height, galvanized, double wall, and hinged, removable access doors on both sides of fan.

D. Access Sections:

1. Provide access sections as shown on the drawings between unit sections. Provide access doors as shown on plans.

E. Fan:

1. Direct Drive Single Width, Single Inlet Plenum with Airfoil Blades:
   a. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type.
   b. Statically and dynamically balanced.
   c. Grease lubricated ball bearings selected for 200,000 hours L-50 life at the design operating conditions.
   d. Provide extended lubrication lines for all bearings to an easily accessible location.
   e. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.
   f. Fan(s) shall have internal spring isolators.
   g. Piezometer Air Flow Measuring: Provide fan with factory installed piezometer ports for monitoring the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Ports shall be installed by the factory to ensure proper location of the taps to match how the fans were tested. Orifices shall be factory drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall extend to a termination plate mounted on the fan housing. High pressure flow probes shall be factory mounted in the low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing. Provide piezometer on each fan in an array. Transducer for measuring differential pressure shall be provided by the Temperature Control Contractor

(TCC). Include with fan submittal the empirically derived formulas developed by the fan manufacturer for each supply and return fan provided with the air handling unit, along with the recommended differential pressure transducer range.

F. Motors and Drives:

1. AC Induction Motors:
   a. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.
   b. Motor mounting bracket shall be adjustable to allow tightening of belts.
   c. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.
   d. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 0513.
   e. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
   f. No equipment shall be selected or operate above 90% of its motor nameplate rating.

G. Variable Frequency Drives:

1. Provided and installed by unit manufacturer. Refer to Section 26 2923 for requirements.

H. Coils:

1. Direct Expansion Coils:
   a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
   b. Galvanized steel casing.
   c. Suitable for 250 psig. Maximum air velocity of 500 fpm.
   d. AHRI rated for direct expansion use with R-410A.
   e. Size coils based on saturated suction temperature, EAT and cfm scheduled. The leaving DB and APD shall not exceed the scheduled values.
   f. Maximum 144 fins per foot. No water carryover shall occur at design airflow and no anti-carryover coating shall be used.
   g. All coils shall be split row or intertwined configuration.
   h. Minimum 0.016" tube wall thickness.
   i. Manufacturers:
      1) Trane
      2) York
      3) Heatcraft
      4) or Daikin

I. Burner and Heat Exchanger

1. Provide electronic modulating natural gas burner capable of modulating gas based on the turn down noted in the schedule. Provide dampers across burner sections to allow for the scheduled minimum air flow noted in drawing schedules. Dampers shall be controlled by burner controller based on modulating input signal for firing rate.
2. Gas Burner: Induced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shutoff, intermittent spark or glow ignition, flame sensing, and automatic 100 percent shutoff pilot.
3. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.

4. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.
5. Provide with 20 gauge, type 409, stainless steel, burners, flue collector, heat exchanger, and tubes on headers on all furnaces.

J. Filter Section:

1. Provide side-loading particulate pre-filter section located as scheduled on drawings. Filter module shall be equipped with framing for 2" deep MERV-8 pleated media filters and 12" deep cartridge filters. Provide pre-filter module with full height hinged access door.
2. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.
3. Reference Section 23 4000 for filter requirements.

K. Mixing and Filter Section:

1. Provide a combination mixing box and angle filter section. Damper arrangement shall be as shown on the drawings. Furnish dampers with the unit. Dampers shall be extruded aluminum with 6" airfoil blades, compressible metal jamb seals, molded synthetic or stainless steel sleeve bearings. The damper shall not leak more than 4 cfm/sq. ft. at 1" W.C. as tested per AMCA Standard 500-D-98. Maximum damper size shall be 48" in length. Provide multiple damper sections for larger lengths. Multiple dampers shall use individual actuators. Jackshafting is not acceptable. Maximum filter velocity shall not exceed specified value. Filters shall be as scheduled and have full size hinged access doors.
2. Provide an angle filter section for 2" thick filters. Maximum filter velocity shall not exceed specified value. Provide full size hinged access doors.
3. Reference Section 23 4000 for filter requirements.

L. Electrical Power:

1. Provide factory-mounted, vapor-tight light fixtures in each accessible section of the unit. The fixture shall be complete with junction box, globe, aluminum globe guard, switch, and bulb. Lighting shall be wired to a single 120-volt point, terminating at a designated junction box mounted on the air-handling unit. The Mechanical Contractor is responsible to complete all wiring connection between shipping splits after assembly.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements

1. Install per manufacturer's instructions.
2. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.
3. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.
4. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

B. Coil Requirements:

1. Comb all coils to repair bent fins.
2. Extend coil drain and vent connections to outside unit housing. Provide normally closed valve on drain and vent connection outside of unit housing.

3.02 MANUFACTURER'S FIELD SERVICES

A. Provide factory authorized field representative for starting unit and training operator.

B. Prepare and start systems with installing contractor observation.

END OF SECTION

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SECTION 23 8200
TERMINAL HEAT TRANSFER UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Finned Tube Radiation.

B. Electric Wall Heaters.

C. Electric Unit Heaters.

1.02 QUALITY ASSURANCE

A. All filters shall be UL listed Class 1 or Class 2.

B. All electrical equipment shall have a UL label.

C. All louvers and dampers shall have AMCA certified ratings.

D. Factory wired equipment shall conform to ANSI/NFPA 70.

1.03 SUBMITTALS

A. Submit shop drawings per Section 23 0500.

B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.

C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.

D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.

E. Submit manufacturers' installation instructions.

F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.04 DELIVERY, STORAGE AND HANDLING

A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.05 REGULATORY REQUIREMENTS

A. Conform to ASHRAE 90.1.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

PART 2 - PRODUCTS

2.01 FINNED TUBE RADIATION - WALL HUNG

A. Cabinets shall be 12 gauge steel with baked enamel finish.

B. Final color selection shall be by the Architect.

C. Element hangers shall be quiet operating, cradle type.

D. Cabinet top shall be continuously supported on wall mounting strips. Lower front face of cabinet shall be secured to the enclosure brackets.

E. All cabinet and accessories shall be securely connected with no exposed fasteners.

F. Provide end caps, corner pieces, adjustable extensions, etc. as required for proper appearance and service.

G. Provide custom cabinet at corners where, in the Architect/Engineer's opinion, standard fittings will not fit correctly or have acceptable appearance. Custom cabinet shall be 14 gauge sheet metal with finish and shape to match manufacturer's cabinet. Submit drawings of each custom cabinet for approval.

H. Provide removable cabinet sections at all control valves. It shall not be necessary to remove several sections to maintain control valves.

I. Support 1/2" tubes on 36" centers and larger tubes on 48" centers.

J. Elements shall be copper tube with aluminum fins.

K. Cabinet size, element length, and element size shall meet the scheduled capacities, but not be less than the sizes scheduled.

L. Products:

1. Vulcan.
2. Sterling.
3. Zehnder-Rittling.
4. Shaw-Perkins.

2.02 ARCHITECTURAL ELECTRIC WALL HEATERS

A. Assembly: UL listed and labeled with terminal box and cover, fan guard, and built-in controls. Draw-through design. Provide with baked enamel finished steel back box suitable for wall mounting.

B. Heating Elements: Nickel-chromium resistance wire enclosed in a steel sheath with copper brazed plate fins.

C. Cabinet: Minimum 20 gauge steel with baked enamel finish. Provide surface mount, semi-recessed or fully recessed cabinet as called for on drawings.

D. Front Panel: Bar grille constructed of minimum 16 gauge cold-rolled steel, welded into a uniform grille and finished in baked enamel. Front grille shall have a satin finished aluminum frame around the periphery.

E. Fan: Direct drive propeller type, statically and dynamically balanced.

F. Motor: Permanently lubricated sleeve bearings, totally enclosed, automatic reset thermal overload protection.

G. Control: Unit-mounted tamper-proof thermostat, thermal cutout, double-pole single throw unit mounted disconnect covered by protective front panel.

H. Manufacturer:

1. Qmark Model AWH.
2. Markel Series 3400.
3. Berko Series FRC.
4. Redd-i.
5. Brasch.

2.03 ELECTRIC UNIT HEATERS

A. Horizontal or vertical discharge as scheduled on the drawings.

B. Horizontal units shall have adjustable outlet louvers.

C. Metal sheathed fin tube electric heating elements.

D. Casing: Heavy gauge steel with baked enamel finish.

E. Automatic reset thermal overload wired for instantaneous pilot operation of contactor holding coil.

F. Motors shall be totally enclosed continuous duty with built-in thermal overload protection.

G. Provide unit mounted and wired disconnect.

H. Provide resiliently mounted fan guard/motor support.

I. Fans: Direct drive propeller type, factory balanced.

J. Manufacturers:
1. Trane.
2. Chromalox.
3. Modine.
4. Reznor.
5. Berko.
6. Redd-i.
7. Brasch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Installation Requirements:
1. Install all products per manufacturers' instructions.
2. Coordinate recess sizes for recessed equipment.
3. Protect units with protective covers during construction.
4. Comb all coils to repair bent fins.

B. Fin Tube:
1. Locate finned tube radiation as shown and run cover wall-to-wall, unless otherwise shown. Center elements under windows.

3.02 CLEANING

A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.

C. Install new filters.

END OF SECTION

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SECTION 26 0500
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 27 0528. This section is also applicable to Fire Alarm and Detection Systems Section 28 3100.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

1.03 SCOPE OF WORK

A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.

B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.

C. Separate contracts will be awarded for the following work.

D. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

E. Description of Systems shall be as follows:

1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
3. Grounding system.
4. Fire alarm system.
5. Security system.
6. Wiring system for temperature control system as shown on the drawings.
7. Lightning protection system.
8. Wiring of equipment furnished by others.
9. Removal work and/or relocation and reuse of existing systems and equipment.
10. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.
11. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.

F. Work Not Included:

1. Telecommunications cabling will be by Division 27, in raceways and conduits furnished and installed as part of the Electrical work.
2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.04 WORK SEQUENCE

A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.

B. Itemize all work and list associated hours and pay scale for each item.

1.05 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, and CONTROL CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
    a. Luminaires.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical bus duct.
    d. Sheet metal.
    e. Cable trays, including access space.
    f. Other piping.
    g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
    a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
    b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
    d. Maintenance clearances and code-required dedicated space shall be included.
    e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
    a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
    a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
    a. Scale of drawings:
        1) General plans: 1/4 Inch = 1 '-0" (minimum).

2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

b. Potential layout changes shall be made to avoid additional access panels.

c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa Codes, Laws, Ordinances and other regulations having jurisdiction.
2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
3. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
6. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.

E. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

F. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
26 05 73	Power System Study
26 09 13	Power Monitoring and Control System
26 09 33	Lighting Control System
26 22 00	Dry Type Transformers
26 24 16	Panelboards
26 24 19	Motor Control
26 27 26	Wiring Devices
26 28 13	Fuses
26 28 16	Disconnect Switches
26 28 21	Contactors
26 29 23	Variable Frequency Drives
26 32 13	Packaged Engine Generator Systems
26 36 00	Transfer Switch
26 41 00	Lightning Protection Equipment
26 43 00	Surge Protection Devices
26 51 19	LED Lighting
26 52 15	Emergency Lighting Inverter
28 31 00	Fire Alarm and Detection Systems
Drawings	Photocells, Timeclocks, Relays

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses

e. Supplier and manufacturer's names and addresses

f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)

g. Description of item submitted (using project nomenclature) and relevant specification number

h. Notations of deviations from the contract documents

i. Other pertinent data

j. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:
    a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
    b. The Contractor shall clearly indicate the size, finish, material, etc.
    c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
    d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 26 XX XX.description.YYYYMMDD
    b. Transmittal file name: 26 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
   a. Material: Delivered cost of product with taxes paid.
   b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
   a. Overhead and profit.
   b. Bonds.
   c. Insurance.
   d. General Requirements: Itemize all requirements.
4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
   a. Each piece of equipment requiring shop drawings. Use the equipment nomenclature (SB-1, PANEL P-1, etc.) on the Schedule of Values.
   b. Each type of small unitary equipment (e.g., FDS, FCS, CS, etc.). Multiple units of the same type can be listed together provided quantities are also listed so unit costs can be determined.
   c. Each conduit system (medium voltage, normal, emergency, low voltage systems, etc.). In addition, for larger projects breakdown the material and labor for each conduit system based on geography (building, floor, and/or wing).
   d. Fire alarm broken down into material and labor for the following:
      1) Engineering
      2) Controllers, devices, sensors, etc.
      3) Conduit
      4) Wiring
      5) Programming
      6) Commissioning
   e. Site utilities (5' beyond building)
   f. Seismic design
   g. Testing
   h. Commissioning
   i. Record drawings
   j. Punchlist and closeout

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.10 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.

B. Keep all materials clean, dry and free from damaging environments.

C. Coordinate the installation of heavy and large equipment with the trade contractors and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.14 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.

B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.

D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.

E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

1.16 PROJECT COMMISSIONING

A. The Contractor shall work with the Commissioning Agent (CxA) as described in Section 01 91 00 and 26 08 00 and provide all services as described in the Commissioning Plan.

PART 2 - PRODUCTS

2.01 GENERAL

A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:
1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:
1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:
1. Utilities Bedding: Lay underground utilities on minimum of 6"sand bedding CA6 crushed stone. Compact bedding under utilities smooth, with no sharp edges protruding, to protect the utilities from puncture. Shape bedding to provide continuous support for bells, joints, and barrels of utilities and for joints and fittings.
2. Envelope around utilities to 6" above utilities: Place and compact sand to a height of 6" over utilities in 6" layers. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement. After connection joints are made, any misalignment can be corrected by tamping backfill around the utilities.
3. Backfill from 6" above utilities to earthen grade: Place all backfill materials above the utilities in uniform layers not exceeding 6" deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.

4. Backfill from 6" above utilities to below slabs or paved area: Where the fill and backfill will ultimately be under a building, floor or paving, each layer of backfill materials shall be compacted to 95% of the maximum density determined by AASHTO Designation T 99 or ASTM Designation D 698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T 99 or ASTM D 698 test.
5. Backfill Materials: Native soil materials may be used as backfill if approved by the Geotechnical Engineer. Backfill material shall be free of rock or gravel larger than 3" in any dimension and shall be free of debris, waste, frozen materials, vegetation, high void content, and other deleterious materials. Water shall not be permitted to rise in unbackfilled trenches.
6. Dispose of excess excavated earth as directed.
7. Backfill all trenches and excavations immediately after installing utilities or removal of forms, unless other protection is provided.
8. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6-inch uniform horizontal layers with each layer compacted separately to required density.

F. Surface Restoration:

1. Where trenches are cut through existing graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.03 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    a. All junction boxes are closed and identified in accordance with Section 26 0553 Electrical Identification.
    b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
    c. Luminaire whips are supported above the ceiling.
    d. Conduit identification is installed in accordance with Section 26 0553 Electrical Identification.
    e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
    f. All wall penetrations have been sealed.
2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

3.04 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.

C. The following must be submitted before Architect/Engineer recommends final payment:

1. Operation and maintenance manuals with copies of approved shop drawings.
2. Record documents including marked-up or reproducible drawings and specifications.
3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
5. Inspection and testing report by the fire alarm system manufacturer.
6. Start-up reports on all equipment requiring a factory installation or start-up.

D. Circuit Directories:

1. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div26.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The instructions shall include:

1. Maintenance of equipment.
2. Start-up procedures for all major equipment.
3. Description of emergency system operation.

E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.

F. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.

G. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.
2. If the Contractor does not have staff that can adequately provide the required instructions, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 RECORD DOCUMENTS

A. The following paragraphs supplement Division 1 requirements.

B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

F. Record actual routing of conduits exceeding 2 inches.

3.08 PAINTING

A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.

B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.

C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.

D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect the color preference before ordering.

E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted; provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

F. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.

G. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.

H. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

3.09 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.

C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.10 SPECIAL REQUIREMENTS

A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.

B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.

C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.

D. Raceway and Cable Routing Restrictions: Raceways and cable are restricted from being routed in the following locations, unless serving the space or permitted by the authority having jurisdiction.

1. Elevator machine rooms and hoistways.
2. Exit enclosures.
3. Other areas restricted by code.
4. Technology, data, server rooms.
5. Fire pump and sprinkler rooms.
6. Normal power in emergency power equipment rooms: Limited to feeders and branch circuits serving the emergency power equipment located in the room.
7. Emergency power in normal power equipment rooms: Limited to feeders and branch circuits serving the normal power equipment located in the room.

3.11 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Within the Limits of Construction:

1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.

2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.

B. Outside the Limits of Construction:

1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.
2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.
3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.

C. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. Trade contractors shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.
2. The Contractor shall continuously maintain the construction zone under a negative pressure of at least 0.01" w.g. minimum relative to all adjacent areas of the building.
    a. Exhaust fans used for this purpose shall filter air and discharge it outdoors or to the least populated area adjacent to the construction work using negative air machines designed specifically for this purpose. All filtration for air recirculated back into the building shall be HEPA (99.97% DOP efficiency) for work adjacent to healthcare or elderly facilities. If no work is adjacent to these areas, 95% filtration is acceptable. Filtering air discharged to outdoors shall be accomplished with 30% filters.
    b. If air is discharged outdoors, maintain all required distances to doors, windows, air intakes, etc.
    c. If high levels of Volatile Organic Compounds (VOC's) or odors are released, activated carbon or equivalent filtration shall also be employed. Exhaust shall not discharge near doors, air intakes, pedestrians, gathering areas, or operable windows.
    d. Adjusting existing air handling equipment to assist in pressure control is acceptable, if approved by the Owner and the authority having jurisdiction.
    e. Seal return, exhaust, and supply air openings in or near the construction zone that serve existing air handling systems, and rebalance the systems for proper operation. If this is impractical, add filters at the intakes of sufficient cross-sectional area to minimize the pressure drop and avoid the need for rebalancing.
    f. Maintain pressure control one hour before and after all construction periods, and 24 hours per day in healthcare or elderly facilities.
3. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
    a. Minimizing the amount of dust generated.
    b. Reducing solvent fumes and VOC emissions.
    c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
4. Request that the Owner designate an IAQ representative.
5. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.

6. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
7. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
8. Request copies of and follow all Owner's IAQ and infection control policies.
9. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
10. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
11. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings under Construction".

3.12 SYSTEM STARTING AND ADJUSTING

A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.

C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.13 FIELD QUALITY CONTROL

A. General:

1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.
3. If the ground resistance value obtained is more than the value set forth in Section 26 0526, the following shall be done to obtain the value given:
    a. Verify that all connections in the service ground system are secure.
    b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
    c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
    d. Review results with the Architect/Engineer.
4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:
    a. Date of test.
    b. Number of hours since the last rain.
    c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
    d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
    e. Make, model, and calibration date of test equipment.
    f. Tabulation of measurements taken and calculations made.

C. Ground-Fault Equipment Performance Testing:

1. Test: Perform ground-fault performance testing when system is installed. The test process shall use primary current injection per manufacturer instruction and procedures. Perform test for the following:
    a. Service disconnects
    b. Solid state molded case circuit breakers and solid-state insulated case circuit breakers equipped with ground fault protection.
    c. Fusible switches with ground fault relay protection.
    d. Outside branch circuits and feeders.
    e. Code required.
2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

D. Arc Energy Reduction Equipment Performance Testing:

1. Test: Perform arc energy protection performance testing when system is installed. The test process shall use primary current injection or approved method per manufacturer instructions and procedures. Perform test for the following:
    a. All arc energy reduction systems installed.
2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

E. Other Equipment:

1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.

F. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.

G. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.

H. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.

I. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

3.14 UTILITY REBATE

A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.

B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Smoke and fire/smoke dampers are wired and have been tested.
4. Per Section 26 0500, cable insulation test results have been submitted.
5. Per Section 26 0500, ground resistance test results have been submitted.
6. Operation and Maintenance manuals have been submitted as per Section 26 0500.
7. Bound copies of approved shop drawings have been submitted as per Section 26 0500.
8. Report of instruction of Owner's representative has been submitted as per Section 26 0500.
9. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
10. Start-up reports from factory representative have been submitted as per Section 26 0500.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION

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SECTION 26 0505
ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.

B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.

C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.

E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.

F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.

G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

3.02 PREPARATION

A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.

B. Coordinate utility service outages with Utility Company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

D. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.

E. Existing Electrical Service: Maintain existing system in service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Service changeover shall be completed on an overtime basis.

F. Existing Fire Alarm System: Maintain existing system in service u. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Provide a watchman to make required premise observations during all outages, requirements as dictated by codes and Owner's insurance carrier.

G. Existing Telephone System: Maintain existing system in service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 72 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. System changeover shall be completed on an overtime basis.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.

D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

E. Disconnect and remove outlets and devices that are to be demolished. Remove outlet or devices' associated back box, supports, and conduit and conductors back to source. Patch opening created from removal of device to match surrounding finishes.

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations under the Toxic Substance Control Act. Provide Owner and Architect/Engineer with a Certificate of Destruction to verify proper disposal.

I. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.

L. HID and fluorescent lamps, determined by the Toxicity Characteristic Leachate procedure (TCLP), to be hazardous waste shall be disposed of in an EPA-permitted hazardous waste disposal facility or by a permitted lamp recycler.

M. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

N. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Remove existing luminaires for cleaning as indicated on the drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, and broken electrical parts. Replacement parts shall match specified components for new luminaires of same type when applicable. Reinstall luminaire and connect to circuiting as indicated on drawings.

D. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.05 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

END OF SECTION

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SECTION 26 0513
WIRE AND CABLE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Building wire

B. Cabling for remote control, signal, and power limited circuits

C. Metal-clad cable (MC)

1.02 RELATED WORK

A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.03 REFERENCES

A. ASTM B801-07 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation

B. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy

C. NFPA 70 - National Electrical Code (NEC)

D. UL 44 - Thermoset-Insulated Wires and Cables

E. UL 83 - Thermoplastic-Insulated Wires and Cables

F. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords

G. UL 2196 - Fire Resistive, Fire Resistant and Circuit Integrity Cables

PART 2 - PRODUCTS

2.01 BUILDING WIRE

A. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.

B. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.

C. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.

D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.

E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.

F. Aluminum conductors are not to be used.

G. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.02 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.

1. Fire alarm
2. Low voltage switching and lighting control
3. Electronic control
4. Other specialized cabling, signal, and power limited cabling. Refer to the appropriate Division 23, 27, or 28 requirements; including, but not limited, to the following:
    a. Building Automation Systems and Controls, Division 23.
    b. Information Technology Backbone and Horizontal Cabling, Division 27.

c. Television Distribution Systems CATV, Division 27.

d. Sound Masking Paging Systems, Professional Audio/Video, Division 27.

e. Electronic Access Control, Intrusion Detection Systems, Video Surveillance, Division 28.

B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.

C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.03 METAL-CLAD CABLE (MC)

A. Conductors shall be copper, 600-volt insulation, THHN. Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Metal-Clad Cables, UL 15694, exterior of metal interlocked armor.

B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

C. Metal-clad cables may be used for branch circuit wiring as defined in the Electrical Code, subject to acceptance by State and local codes.

PART 3 - EXECUTION

3.01 WIRE AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings:

1. Building wire shall be installed in raceway.

2. Metal clad cable, Type MC, 1/2" size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires on non-essential circuits. The flexible whips shall be between 18" to 72" in length per Electrical Code.

B. All Other Locations: Building wire in raceway.

C. Above Grade: All conductors installed above grade shall be type "THHN".

D. Underground or In Slab: All conductors shall be type "THWN".

E. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.

F. Fire-Rated 2-Hour Feeders and Circuit Requiring Continuous Operation (CI): Refer to Part 2 of this section for acceptable products and assemblies. Installation shall meet UL 2196.

3.02 CONTRACTOR CHANGES

A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)). Conductors are based on copper conductor installed in underground electrical ducts.

B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.

C. Record drawing shall include the calculations and sketches.

3.03 GENERAL WIRING METHODS

A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.

B. Use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.

C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

D. Use no wire smaller than 8 AWG for outdoor lighting circuits.

E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

G. Splice only in junction or outlet boxes.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Make conductor lengths for parallel circuits equal.

J. All conductors shall be continuous in conduit from last outlet to their termination.

K. Terminate all spare conductors on terminal blocks, and label the spare conductors.

L. Cables or wires shall not be laid out on the ground before pulling.

M. Cables or wires shall not be dragged over earth or paving.

N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.

O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.

P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.04 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.

D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.

E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.

F. Only nylon rope shall be permitted to pull cables into conduit and ducts.

G. Completely and thoroughly swab raceway system before installing conductors.

H. Conductor Supports in Vertical Raceways:

1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.

2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.05 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Use suitable cable fittings and connectors.

C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when

shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.

D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.

E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.

G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.06 WIRING CONNECTIONS AND TERMINATIONS

A. Splice and tap only in accessible junction boxes.

B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.

C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.

D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.

F. Thoroughly clean wires before installing lugs and connectors.

G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.

I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:

1. Facing the front and operating side of the equipment, the phase identification shall be:
    a. Left to Right - A-B-C
    b. Top to Bottom - A-B-C

J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.07 MC CABLE INSTALLATION

A. AC/MC shall NOT be used for circuits serving the Essential Electrical System.

B. Cable shall be supported by an approved means every 4.5' and within 12" of outlet boxes, junction boxes, cabinets, or fittings.

C. Cable may be unsupported in the following conditions:

1. Cable is no longer than 2' in length at terminals where flexibility is necessary.
2. Cable is not more than 4.5' from the last point of support for connections within an accessible ceiling to light fixtures or equipment.

D. Conductor ampacity shall be derated as required by the Electrical Code where more than three current carrying conductors are used.

E. Each 120 and 277-volt circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for cable derating.

F. Cables shall be cut using a rotary cutter as recommended by the manufacturer to eliminate nicking and cutting of the conductors.

G. Bending radius shall comply with the requirements listed in the Electrical Code for the type and size of cable being installed, but shall not be less than 5-times the diameter of the cable in any case.

H. At cable terminations, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an insulating bushing or its equivalent protection shall be provided between the conductors and the armor.

I. All wiring devices supplied by nonmetallic-sheathed cables shall be mounted in an outlet box.

3.08 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.

C. Inspect wire and cable for physical damage and proper connection.

D. Torque test conductor connections and terminations to manufacturer's recommended values.

E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

F. Provide documentation of the manufacturer's recommended lug torque value for copper conductors, the date the lugs were torqued, and installed torque readings. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.

G. Protection of wire and cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.

H. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION

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SECTION 26 0526
GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Equipment grounding system

B. Bonding system

C. Grounding electrode system

1.02 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with UL 467 Grounding and Bonding Equipment.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with Electrical Code; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

1.03 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

B. NFPA 99 - Standard for Healthcare Facilities

1.04 SUMMARY

A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

PART 2 - PRODUCTS

2.01 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section 26 0513 "Wire and Cable".

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated. Refer to Section 26 0553 for insulation color.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

G. Aluminum Bonding Conductors: As follows:

1. Bonding Cable: 10 strands of No. 14 AWG aluminum conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded aluminum conductor.

3. Bonding Jumper: Aluminum tape, braided bare aluminum conductors, terminated with aluminum ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.02 CONNECTOR PRODUCTS

A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Connectors: Hydraulic compression type, in kit form, and selected per manufacturer's written instructions.

C. Bolted Connectors: Bolted-pressure-type connectors.

D. Substation connectors shall comply with IEEE 837 listed for use for specific types, sizes, and combinations of conductors and connected items.

2.03 GROUNDING ELECTRODES

A. Ground Rods Copper-clad steel.

B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

C. Test Wells: Provide handholes as shown on drawings or as specified in Division 2 Section "Underground Ducts and Utility Structures."

D. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to Electrical Code, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet of 1/2"steel reinforcing bar.

PART 3 - EXECUTION

3.01 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.

G. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.

H. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.

I. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity. The connection to the non-metallic boxes shall be made to any metallic fitting or device requiring grounding.

J. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

K. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.02 INSTALLATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.

C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.

D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

E. In raceways, use insulated equipment grounding conductors.

F. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

G. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, below access floors, and elsewhere as indicated, with bolted connections to form a continuous ground path.

3.03 EQUIPMENT GROUNDING SYSTEM

A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.

B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by Electrical Code:

1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
2. Single-phase and three-phase motor and appliance branch circuits.
3. Flexible raceway runs, including FMC and LFMC.
4. Armored and metal-clad cable runs.

D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.04 BONDING SYSTEM

A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.

B. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.

C. Equipment Circuits: Install a bonding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, dampers, and heaters. Bond conductor to each unit and to air duct. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps or copper conductor sized equal to the equipment grounding conductor.

D. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.

E. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.

G. Telecom Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bar.

H. Terminal Cabinets: Terminate bonding conductor on cabinet grounding terminal.

I. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

J. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.05 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
4. Testing: Perform the following field quality-control testing:
    a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
    b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

1) Equipment Rated 500 kVA and Less: 10 ohms.

2) Equipment Rated 500 to 1000 kVA: 5 ohms.

3) Equipment Rated More Than 1000 kVA: 3 ohms.

4) Substations and Pad-Mounted Switching Equipment: 5 ohms.

5) Manhole Grounds: 10 ohms.

d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.06 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION

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SECTION 26 0527
SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Conduit and Equipment Supports

B. Fastening Hardware

C. Concrete Housekeeping Pads

D. Foundation and Underground Sleeves and Seals

1.02 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.03 COORDINATION

A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Allied Support Systems

B. Cooper B-Line

C. Erico, Inc.

D. Hilti

E. Power Fasteners

F. Orbit Industries

2.02 MATERIAL

A. Support Channel: stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.

B. Hardware: Corrosion resistant.

C. Anchorage and Structural Attachment Components:

1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
    a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
3. Welding Lugs: Comply with MSS-SP-69, Type 57.
4. Beam clamps for Steel Beams and Joists: Double sided or concentric open web joist hangars. Single-sided type is not acceptable.
5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural General Notes for lintel requirements in masonry construction.
3. Refer to Structural plans and specifications for lintel requirements and sizes.
4. Lintels:
   a. Lintels in non-bearing masonry wall openings can be sized in accordance with the note below. Lintels that occur in existing bearing walls are to be sized according to similar conditions and spans in the new construction and lintel schedule. Bottom plate size shall be a minimum of 3/8" thick. The width of the plate shall be 3/4" less than the field verified wall thickness. The plate shall be the full length of the lintel member. Lintels are not required over openings that are 12" wide or less and at least 1 course below the top of the wall.
   b. All lintels shall have a minimum of 8" end bearing.
   c. All lintels in exterior wall construction shall be hot-dip galvanized.
   d. For all openings not otherwise detailed or scheduled, minimum lintels shall be for each 4 inch of masonry width:
      1) 0 to 2'-0" span: 5/16" plate (3/4" less than wall width)
      2) 2'-0" to 4'-0" span: L 3 1/2 x 3 1/2 x 1/4
      3) 4'-0" to 6'-0" span: L4 x 3 1/2 x 5/16 (llv)
      4) 6'-0" to 8'-0" span: L5 x 3 1/2 x 5/16 (llv)
   e. All angles that are back to back shall be welded top and bottom 3" at 12" minimum.
5. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
6. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
7. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
8. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
9. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
10. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
11. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
12. Size sleeves large enough to allow expansion and contraction movement.

E. Concrete Housekeeping Pads:

1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.

2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.

F. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
4. Products:
   a. Anvil International HBS-Base Series
   b. Cooper B-Line Dura-Blok
   c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

G. Truss and Joist Support System: Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
   a. The hanger is attached within 6" from a web/chord joint.
   b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.

2.03 FOUNDATION - UNDERGROUND SLEEVES AND SEALS

A. Wall Seals ("Link-Seals"):

1. Where shown on the drawings, raceways passing through foundation walls to an underground condition shall have their annual space (sleeve or drilled hole “” not tapered hole made with knockout plug) sealed by properly sized sealing element consisting of a synthetic rubber material compounded to resist aging, ozone, sunlight, water and chemical action.
2. Sleeves, if used, shall be standard weight steel with primed finish and waterstop/anchor continuously welded to sleeve.
3. Sleeves shall be at least 2 trade sizes larger than the penetrating raceway.
4. Pressure shall be maintained by stainless steel bolts and accessories. Pressure plates may be of composite materials for Models S and OS.

5. Sealing Elements shall be as follows:

Model	Service	Element Material	Temperature Range
S	Standard (Stainless)	EPDM	-40°F to 250°F
T	Fire Seals (1 hour)	Silicone	-67°F to 400°F
FS	Fire Seals (3 hours)	Silicone	-67°F to 400°F
OS	Oil Resistant / Stainless	Nitrile	-40°F to 210°F

6. Approved Manufacturers:
   a. Thunderline Corporation "Link-Seals"
   b. O-Z/Gedney Company
   c. Calpico, Inc
   d. Innerlynx

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.

B. Trapeze support installation: Cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.

C. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

D. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.

E. Do not use powder-actuated anchors without specific permission.

F. Do not drill structural steel members.

G. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

H. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.

I. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting.

J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

K. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

L. Refer to Section 26 0533 for special conduit supporting requirements.

3.02 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION

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SECTION 26 0533
CONDUIT AND BOXES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Rigid metallic conduit and fittings (RMC)
B. Electrical metallic tubing and fittings (EMT)
C. Flexible metallic conduit and fittings (FMC)
D. Liquidtight flexible metallic conduit and fittings (LFMC)
E. Rigid polyvinyl chloride conduit and fittings (PVC)
F. Wall and ceiling outlet boxes
G. Electrical connection
H. Pull and junction boxes
I. Accessories

1.02 RELATED WORK

A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.03 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
   2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
   3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
   4. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
   5. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
B. Federal Specifications (FS):
   1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
   2. A-A-55810 - Specification for Flexible Metal Conduit
C. NECA "Standards of Installation"
D. National Electrical Manufacturers Association (NEMA):
   1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
   2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
   3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
E. NFPA 70 - National Electrical Code (NEC)
F. Underwriters Laboratories (UL): Applicable Listings
   1. UL 1 - Flexible Metal Conduit
   2. UL 6 - Rigid Metal Conduit
   3. UL 360 - Liquid Tight Flexible Steel Conduit
   4. UL514-B - Conduit Tubing and Cable Fittings
   5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
   6. UL746A - Standard for Polymeric Materials - Short Term Property Evaluations
   7. UL797 - Electrical Metal Tubing

G. American Standard of Testing and Materials (ASTM):
1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material

H. Definitions:
1. Fittings: Conduit connection or coupling.
2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.
5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

PART 2 - PRODUCTS

2.01 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Manufacturers:
1. Allied
2. LTV
3. Steelduct
4. Calbond Calpipe
5. Wheatland Tube Co
6. O-Z Gedney
7. or approved equal.

B. Manufacturers of RMC Conduit Fittings:
1. Appleton Electric
2. O-Z/Gedney Co.
3. Electroline
4. Raco
5. Bridgeport
6. Midwest
7. Regal
8. Thomas & Betts
9. Crouse-Hinds

10. Killark
11. Orbit Industries
12. or approved equal.

C. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

D. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

E. PVC Externally Coated Conduit: Compliant with UL 6, ANSI C80.1 and NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. Threads shall be hot galvanized and coated with a clear coat of urethane. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system.

1. Acceptable Manufacturers:
    a. Calbond Calpipe
    b. Robroy
    c. T&B Ocal
    d. or approved equal.

2.02 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Manufacturers of EMT Conduit:

1. Allied
2. Calbond Calpipe
3. LTV
4. Steelduct
5. Wheatland Tube Co
6. or approved equal.

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.
2. 1/2" and 3/4" Conduit: Push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
3. Larger than 2": Compression type of steel designed for their specific application.
4. Manufacturers of EMT Conduit Fittings:
    a. Appleton Electric
    b. O-Z/Gedney Co.
    c. Electroline

d. Raco
e. Bridgeport
f. Midwest
g. Regal
h. Thomas & Betts
i. Orbit Industries
j. or approved equal.

2.03 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.

B. Manufacturers:
1. American Flex
2. Alflex
3. Electri-Flex Co
4. or approved equal.

C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

D. Fittings and Conduit Bodies:
1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
a. O-Z/Gedney Co.
b. Thomas & Betts
c. Appleton Electric
d. Electroline
e. Bridgeport
f. Midwest
g. Regal
h. Orbit Industries
i. or approved equal.

2.04 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Manufacturers:
1. Anaconda Type UA
2. Electri-Flex Type LA
3. Alflex
4. Carlon (Lamson & Sessions)
5. or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
3. Manufacturers:
    a. Appleton Electric
    b. O-Z/Gedney Co.
    c. Electroline
    d. Bridgeport
    e. Thomas & Betts
    f. Midwest
    g. Regal
    h. Carlon (Lamson & Sessions)
    i. Orbit Industries
    j. or approved equal.

2.05 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers:

1. Carlon (Lamson & Sessions) Type 40
2. Cantex, J.M. Mfg.
3. or approved equal.

C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.

D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.06 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.

B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.

C. Cast Boxes: Nema FB1, Type FD, Aluminum, cast feralloy, or stainless steel deep type, gasketed cover, threaded hubs.

D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.

F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.

G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.07 ECONN; ELECTRICAL CONNECTION

A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.08 JB; PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.

B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.

C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

E. Flanged type boxes shall be used where installed flush in wall.

PART 3 - EXECUTION

3.01 INSTALLATION TRAINING

A. PVC coated rigid metal conduit manufacturers shall provide Contractor installation training for field cutting, joint preparation, joint assembly, field bending, and field cut sealing.

3.02 CONDUIT INSTALLATION SCHEDULE AND SIZING

A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.

B. Installation Schedule: Refer to drawings.

C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

D. Minimum Conduit Size (Unless Noted Otherwise):

1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
2. Below Grade 5' or less from Building Foundation: 1 inch.
3. Below Grade More than 5' from Building Foundation: 1 inch.
4. Telecommunication Conduit: 1 inch.
5. Controls Conduit: 1/2 inch.

E. Conduit Embedded in Slabs above Grade:

1. Embedded installation NOT allowed in elevated slabs with metal composite decks nor structural pour in place slabs less than 6 inches in depth unless specifically noted or shown on drawings otherwise.
2. Maximum size 1-1/4 inch for conduits crossing each other.

F. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.03 CONDUIT ARRANGEMENT

A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.

B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.

C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):

1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3" concrete cover.
2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.

D. Conduit shall not share the same cell as structural reinforcement in masonry walls.

E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.

F. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.

G. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.04 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

1. Support wire used to independently support raceway and wiring systems above suspending ceilings shall be supported on both ends, minimum 12 gauge suspended ceiling support wire, and distinguishable from ceiling support systems by color (field paint), tagging, or equivalent means.

B. Conduit shall <u>not</u> be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.

F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.

G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.

L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:

1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.05 CONDUIT INSTALLATION

A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.

4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
    a. A third bend is acceptable if:
        1) The total run is not longer than (33) feet.
        2) The conduit size is increased to the next trade size.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.
8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:
1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. .
7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system, equal to O-Z/Gedney type EYD.
9. Horizontal conduit routing through slabs above grade
    a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3" min. concrete cover. Conduits shall run parallel to each other and spaced at least 8" apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1".
    b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.
    c. No conduits are allowed to be routed horizontally through slabs above grade.
10. Do not route conduits across each other in slabs on grade.

11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.
12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.
17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

3.06 CONDUIT TERMINATIONS

A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.

B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.

F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.

G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.07 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.

2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f'c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

F. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with "JackMoon" or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).
3. Duct Seal Alternative Option: Inflatable duct seal system. Capable of withstanding a 10-foot head of water (5 PSEI).
    a. Manufacturers:
        1) Raychem Rayflate Duct Sealing Systems RDSS
        2) Approved equal

3.08 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
3. Direct contact with concrete except slab on grade.
4. Recessed in stud wall of kitchens and laundries.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Hazardous locations.
3. Exposed interior locations within 8' of the highest platform level.
4. Direct contact with earth.
5. Direct contact with concrete in slab on grade.
6. Wet locations.
7. Kitchens and laundries when exposed on wall surface.

3.09 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer.

D. Locate and install to maintain headroom and to present a neat appearance.

E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.10 OUTLET BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)

D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.

E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.

F. Provide knockout closures for unused openings.

G. Support boxes independently of conduit.

H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.

K. Position outlets to locate luminaires as shown on reflected ceiling drawings.

L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.11 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

B. Support pull and junction boxes independent of conduit.

C. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.

2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.12 EXPOSED BOX INSTALLATION

A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.

B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.

C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.

D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.

E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)

F. Wood, plastic, or fiber plugs shall not be used for fastenings.

G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION

SECTION 26 0553
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Adhesive Markings and Field Labels

B. Nameplates and Signs

C. Product Colors

1.02 REFERENCES

A. NFPA 70E - National Electrical Safety Code

B. NFPA 70 - National Electrical Code (NEC)

C. ANSI A13.1 - Standard for Pipe Identification

D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

PART 2 - PRODUCTS

2.01 ADHESIVE MARKINGS AND FIELD LABELS

A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).

1. Label Size as follows:

a. Raceways: Kroy or Brother labels 1-inch high by 12-inches long (minimum).

2. Color: As specified for various systems.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40°F to 185°F (-40°C to 85°C), type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.

F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.

G. Aluminum, Wraparound Marker Bands: 1-inch width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

H. Brass or Aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch metal tags with stamped legend, punched for fastener.

I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

J. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.

a. Font: Normal 721 Swiss Bold

b. Adhesive Labels: 3/16 inch minimum text height

c. Vinyl / Plastic Laminate Labels: 3/4" inch minimum text height

2.02 NAMEPLATES AND SIGNS

A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.

B. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
    a. Text Height: 3/8 inch minimum

C. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting ¼" grommets in corners.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.

E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.03 PRODUCT COLORS

A. Adhesive Markings and Field Labels:

1. All Labels: Black letters on white face
2. Normal Power and General Labels: Black letters on white face
3. Control Labels: Black letters on white face
4. Fire Alarm: Red letters on white face
5. Emergency: Red letters on white face

B. Nameplates and Signs:

1. NORMAL POWER: Black letters on white face
2. Control Labels: Black letters on white face
3. EMERGENCY: White letters on red face
4. GROUNDING: White letters on green face.
5. CAUTION or UPS: Black letters on yellow face

C. Raceways and Conduit:

1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
    a. Normal Power and General Distribution: Silver
    b. Emergency Power Distribution System:
        1) Optional Standby: Orange
        2) Life Safety and Critical Branch: Yellow
        3) Equipment Branch: Orange
    c. Fire Alarm System: Red
    d. Temperature Controls: Refer to mechanical cover sheet for color
    e. Ground: Green

D. Box Covers:

1. Box cover colors shall match conduit colors listed above.

E. Conductor Color Identification: Refer to Part 3 for additional information.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.

B. Exposed Ceilings and Finished Spaces: The project includes exposed ceilings in finished spaces. The installation of colored raceways and labeling may not be aesthetically desirable in finished spaces. The contractor shall coordinate identification requirements in exposed ceilings of finished spaces with the A/E prior to installation and ordering of materials.

C. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

E. Circuit Identification: Tag or label conductors as follows:

1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

F. Apply warning, caution and instruction signs as follows:

1. Install warning, caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

G. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.

H. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

I. Install ARC FLASH WARNING signs on all power distribution equipment per Section 26 0573.

! WARNING
ARC FLASH AND SHOCK HAZARD
APPROPRIATE PPE REQUIRED
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY
REFER TO NFPA 70E

J. Circuits with more than 600V: Identify raceway and cable with "DANGER-HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot intervals.

1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to conduits concealed within wall.
3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Selective Coordination Label: Install caution signs on all switchboards, distribution panels, panelboards, disconnects, and other equipment with selectively coordinated overcurrent protection devices. Sign at a minimum shall contain:

1. CAUTION: OVERCURRENT DEVICES IN THIS ENCLOSURE ARE SELECTIVELY COORDINATED. EQUIVALENT REPLACEMENTS AND TRIP SETTINGS ARE REQUIRED.

L. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.02 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

C. Identification material to be engraved plastic-laminated labels, 1/16-inch minimum thickness with white letters on a red face. Letter and number size to 1/8-inch high.

D. Identification to be engraved directly on the stainless steel coverplates. Letter and number size to 1/8-inch high.

E. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24"). Identification for switch cover plates shall be installed on the inside cover.

3.03 CONDUIT AND EXPOSED CABLE LABELING

A. Product:

1. Adhesive labels and field markings

B. Conduit Identification: Pre-printed, flexible, self-adhesive vinyl labels with legend at 20 foot (6 meter) intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible, or separated by enclosures, walls, partitions, ceilings, and floors. Labels for multiple conduits shall be aligned. Refer to color requirements in Part 2 when applicable in addition to the following:

1. 1000 Volt or less Normal/Emergency Power: Indicate feeder identification and voltage.
2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
3. Fire Alarm: Indicate "FIRE ALARM".
4. Grounding: Indicate "GROUND" and equipment and designation.
5. Security System: Indicate "Security".
6. Telephone System: Indicate "Telephone".

C. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

3.04 BOX LABELING

A. Products:

1. Adhesive labels and field markings

B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape OR Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

C. All junction, pull, and connection boxes shall be identified as follows:

1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
2. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Maximum interval between label intervals shall be 25 feet or as required by code.
3. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

3.05 CONDUCTOR COLOR CODING

A. Products:

1. All wire and cables shall be color coded by the manufacturer.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.

D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

E. Conductors shall be color coded as follows:

1. 208Y/120 Volt, 4-Wire:
   a. A-Phase - Black
   b. B-Phase - Red
   c. C-Phase - Blue
   d. Neutral - White
   e. Ground Bond - Green
2. 480Y/277 Volt, 4-Wire:
   a. A-Phase - Brown
   b. B-Phase - Orange
   c. C-Phase - Yellow
   d. Neutral - Gray
   e. Ground Bond - Green
3. Grounding Conductors:
   a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
4. Cabling for Remote Control, Signal, and Power Limited Circuits:
   a. Fire Alarm: Red.
   b. Low Voltage Switching: Per manufacturer recommendations and code requirements.

c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.

d. Electronic Control: Per manufacturer recommendations and code requirements.

e. Structured Cabling: Refer to Division 27.

3.06 CONTROL EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served.
2. Location of equipment being served if it is not located within sight.
3. Voltage and phase of circuit(s).
4. Panel and circuit number(s) serving the equipment.
5. Method of automatic control, if included ("AUTO CONTROL BY FMCS").
6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
7. Date of fault current study, refer to one-line diagram
8. Sample Label:
   EXHAUST FAN EF-1 ("LOCATED ON ROOF")
   480V, 3-PHASE
   FED FROM "1HA1-1"
   AUTO CONTROL BY FMCS
   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.07 EQUIPMENT CONNECTION IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner. The following list of equipment is specifically being listed to receive an equipment connection label; this list does not limit the equipment that shall receive a label:

1. Mechanical heating, ventilation, and air conditioning equipment; chillers, boilers, pumps, air handing ventilation units, condensing units, unit heaters, and similar equipment
2. Plumbing equipment
3. Fire protection equipment including fire pumps
4. Kitchen equipment (hardwired)

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served
2. Location of equipment being served if it is not located within sight.
3. Voltage and rating of the equipment.
4. Panel and circuit numbers(s) serving the equipment
5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.

6. Date of fault current study; refer to one-line diagram
7. Sample Label:

   UNIT HEATER UH-1 ("LOCATED IN STORAGE ROOM 200")
   480V: 3-PHASE
   FED FROM "1HA1-1"
   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.08 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Products:
   1. Nameplates and signs

B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.
   1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
   2. Exterior Equipment: The identification material shall be engraved vinyl labels.
   3. Labeling shall include:
      a. Essential Electrical System EES: When applicable the label shall include "Essential Electrical System EES". Applicable equipment includes components of the life safety and critical branch for healthcare facilities (generators, transfer switches, switchboards, distribution panels, panelboards, etc.).
      b. Equipment type and contract documents designation of equipment.
      c. Voltage of the equipment.
      d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
      e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
      f. Sample Label:

         DISTRIBUTION PANEL DP-H1
         480Y/277V
         FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)
   4. Provide the following on a separate label, installed below the label above:
      a. Available fault current; refer to one-line diagram or panel schedules
      b. Date of fault current study; refer to one-line diagram
      c. Sample Label:

         22,000 AMPS AVAILABLE FAULT CURRENT
         DATE OF STUDY: 1 JAN 2017

C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:
   1. Nominal system voltage, service wire size, quantity, material, distance
   2. Maximum available fault current; refer to one-line diagram for values
   3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 26 0573 for value.
   4. Date of fault current study; refer to one-line diagram
   5. Date of label

6. Sample Label:

   480Y/277V, 6 SETS 4#750KCM CU, 75FT
   39,800 AMPS AVAILABLE FAULT CURRENT
   0.07 SECOND CLEARING TIME
   DATE OF STUDY: 1 JAN 2017
   DATE OF LABEL: 4 JUL 2017

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.
   a. Label: "This equipment is designed with a system listed below".
   b. Applicable Systems:
      1) Zone-selective interlocking system for selective coordination and arc energy reduction
      2) Differential relaying system for selective coordination and arc energy reduction
      3) Arc energy reducing maintenance switch
      4) Energy reducing active arc flash mitigation system

E. Adjustable-Trip Over Current Protection Label:

1. Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with adjustable trip settings. Provide label separate from load identification label.
   a. Label:
      1) Long-time delay:
      2) Long-time pickup:
      3) Short-time delay:
      4) Short-time pickup:
      5) Instantaneous:
      6) Ground fault delay:
      7) Ground fault:
   b. Sample Label:

Long-time delay:	10.0
Long-time pickup:	1.0
Short-time delay:	0.15
Short-time pickup:	5.0
Instantaneous:	2.0
Ground fault delay:	0.25
Ground fault:	50.0

F. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

G. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent projection device with feeder wire size, feeder wire quantity, conductor material and distance in feet. Provide label separate from load identification label and adjustable trip settings label.

1. Sample Labels for Feeders:

   4#3/0 CU & 1#6 CU GND, 125FT
   4#250KCM AL & 1#6 GND CU, 125FT
   2 SETS 4#400KCM CU & 1#1 GND CU, 125FT

H. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 0500 for other requirements.

3.09 TRANSFORMER EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.

C. Labeling shall include:

1. Equipment type and contract documents designation of equipment
2. Name of the upstream equipment.
3. Voltage and rating of the equipment.
4. Location of the upstream equipment if it is not located within sight.
5. Sample Label:

   TRANSFORMER TR-15
   480V: 208Y/120V 15KVA
   FED FROM SWITCHBOARD "SB-1" (LOCATED IN ELEC 123)

3.10 ELECTRICAL WORKING CLEARANCE IDENTIFICATION

A. Products:

1. Safety Yellow paint and custom stencils

B. Provide custom identification of electrical equipment working clearances in mechanical, electrical, storage, janitorial, and similar non-public areas.

C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch wide stripes.

1. Width of area: Width of equipment or as required by code
2. Depth of area: Depth as required by code

END OF SECTION

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SECTION 26 0573
POWER SYSTEM STUDY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Low voltage distribution system power study.

B. Short-circuit analysis and report.

C. Selective coordination analysis and report.

D. Arc-flash hazard analysis and report.

1.02 RELATED SECTIONS

A. Section 26 0500 - Basic Electrical Requirements

B. Section 26 2413 - Switchboards

C. Section 26 2416 - Panelboards

D. Section 26 3213 - Packaged Engine Generator Systems

E. Section 26 3600 - Transfer Switch

1.03 QUALITY ASSURANCE

A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections.

1.04 SUBMITTALS

A. Documentation shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.

B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths and field investigation of existing equipment types, sizes, ratings provided by the Electrical Contractor. IMEG will provide a preliminary Power Tools for Windows project file for information, if requested.

C. Documentation of the analyses shall be submitted in a single bound electronic (PDF or equal) format and shall accompany the shop drawing submittals for equipment provided under the related work specification sections. The submittal of these related specification sections will not be reviewed without this documentation. Submit a sample arc-flash hazard label for Owner review and approval prior to printing.

D. Power system study project model shall be submitted on electronic media for review and the Owner's operating and maintenance records.

1.05 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

B. NFPA 70E - Standard for Electrical Safety in the Workplace

C. IEEE 1584 - IEEE Guide for Performing Arc-Flash Hazard Calculations, latest version

D. ANSI Z535.4 - Products Safety Signs and Labels

1.06 SCOPE

A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.

B. Contractor is required to provide a fully coordinated system for the normal and essential emergency electrical system or essential emergency electrical system and the associated normal side of each transfer switch and all other locations indicated on the one line diagram. Contractor shall provide overcurrent protective devices with the appropriate models, frame sizes, trip units, etc. as required to provide a selectively coordinated system.

PART 2 - PRODUCTS

2.01 Power systems study shall be completed in Power Tools for Windows (PTW) 8.0 or later version or pre-approved equivalent program.

PART 3 - EXECUTION

3.01 SHORT-CIRCUIT ANALYSIS

A. Provide a complete short-circuit analysis from the utility service to and including the entire building distribution as shown on the drawings.

B. Analysis shall include the entire distribution system from the point of connection to the utility power source to the distribution panels and branch circuit panelboards.

C. Short-circuit analysis documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted and made available to the AHJ if requested.

3.02 SELECTIVE COORDINATION ANALYSIS

A. Provide a complete selective coordination analysis comparing time/current curves of the protective devices to be installed to assure coordination between main and downstream devices. Overcurrent protection devices shall be coordinated based on the maximum available fault current results of the short-circuit analysis report.

B. Provide a complete selective coordination analysis, comparing time/current curves of the protective devices to be installed to assure complete selectivity between main and downstream devices for code-required branches and branches identified on one-line drawings. Overcurrent protective devices serving the essential electrical system shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01 second. Overcurrent protective devices serving the normal shall selectively coordinate for the period of time that a fault's duration extends beyond 0.01.

C. Provide trip settings for all (selectively coordinated and non-selectively coordinated) adjustable trip over current protection devices including long time delay, long time pickup, short time delay, short time pickup, instantaneous and ground fault. Selectively coordinated branches shall be based on the selective coordination study results. Non-selective coordinated branches shall be based on the design trip ratings. Provide selective coordination between all ground fault trip settings.

D. The analysis shall include primary protective device, secondary main switchboard device(s), switchboard branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.

E. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.

1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.
2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.
3. Each primary protective device required for the transformer shall be selected so the characteristics or operating band is within the transformer parameters, which shall include a parameter equivalent to 58% of the withstand point to afford protection for secondary line-to-ground faults. The transformer damage curve shall be included for the transformer when the selected protective device is not within the associated parameters.
4. Molded case circuit breakers shall be separated from each other and the associated primary protective device by a 16% current margin for coordination and protection in the event of secondary line-to-line faults.

5. Include zone selective interlocking, differential relaying, and other selective coordination technology in the study when required by other specification sections.
6. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.
7. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.
    a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.

F. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.

3.03 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.

C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit analysis and coordination study models. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
    1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.
    2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

H. Include Arc Energy Reduction (AER) analysis in the study when required by other specification sections.

I. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.

J. Miscoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.

M. Labels shall be vinyl or laminated, with a self-adhesive backing, conform with ANSI Z535.4 Products Safety Signs and Labels standard, and include the following:

1. Arc flash boundary
2. Available incident energy calculated in the analysis and the corresponding working distance, or the arc flash personal protective equipment (PPE category) for the equipment, but not both.

N. Examples showing the minimum required information follow:

O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

3.04 ADJUSTMENTS

A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study. Apply settings prior to placing equipment into operation. When the scope of work or execution includes remodel or phases construction, the contractor shall adjust applicable settings as required prior to each system component placed in operation.

B. Wherever the arc flash incident energy exceeds Arc Flash Category 2 (i.e. greater than 8 cal/cm^2), provide options for adjusting breaker trip times, if possible, to reduce energies to Category 2 or below.

3.05 TRAINING

A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

END OF SECTION

SECTION 26 0800
ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.

B. This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.

C. The Commissioning Provider (CxP) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.

D. The electrical equipment and systems to be commissioned, including commissioning activities for the following specific items:
   1. Automatic Transfer Switch
   2. Packaged Engine Generator
   3. Lighting Controls
   4. Fire Alarm Monitoring
   5. Variable frequency drives.
   6. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.

E. The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 RELATED REQUIREMENTS

A. Section 017800 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.

B. Section 017900 - Demonstration and Training: Scope and procedures for Owner personnel training.

C. Section 019113 – General Commissioning Requirements

D. Section 26 0933 – Lighting Control Systems.

E. Section 26 3213 – Packaged Engine Generator Systems.

F. Section 26 3600 – Transfer Switch.

1.03 REFERENCE STANDARDS

A. ASHRAE Guideline 0-2013 – The Commissioning Process.

B. ASHRAE Standard 202-2018 - Commissioning Process for Buildings and Systems.

1.04 SUBMITTALS

A. Updated Submittals: Keep the Commissioning Provider informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.

B. Draft Prefunctional Checklists and Functional Test Procedures: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
   1. System name.
   2. List of devices.
   3. Step-by-step procedures for testing equipment or system.
   4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to

specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.

5. Description of the instrumentation required for testing.

C. Startup Reports: Submit for approval of Commissioning Provider.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.

B. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 GENERAL

A. Cloud based software will be utilized for maintaining Prefunctional Checklists, Functional Performance Testing and Issue management. Contractors will be required to utilize the system. Logins will be provided to the contractors, and the software does not require a subscription fee from the contractors.

3.02 PREPARATION

A. Cooperate with the Commissioning Provider in development of the Prefunctional Checklists and Functional Test Procedures.

B. Furnish additional information requested by the Commissioning Provider.

C. Coordinate with the Owner, GC / CM and all other trade contractors for testing of generator and transfer switches. Engage equipment supplier, vendor or start-up technicians for support during loss of power testing. Trade contractor shall also coordinate with the electric utility company if it is deemed necessary to fully disconnect from the utility power source to test the generator and transfer switch. Trade Contractor(s) shall provide necessary field technicians to troubleshoot and adjust items on site during generator and transfer switch testing.

D. If load bank testing of generators, UPS or inverter systems will be utilized, notify Commissioning Provider no less than 96 hours in advance or testing.

3.03 INSPECTING AND TESTING - GENERAL

A. Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.

B. Perform the Functional Tests directed by the Commissioning Provider for each item of equipment or other assembly to be commissioned.

C. Provide two-way radios for use during the testing.

D. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.04 FUNCTIONAL TESTING

A. Prefunctional Checklists for equipment, system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.

B. Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.

C. Using a skilled technician who is familiar with this equipment or system, execute the Functional Testing of the equipment or system as required by the Commissioning Provider.

D. If the equipment or system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 DEMONSTRATION AND TRAINING

A. See Section 01 7900 for additional requirements.

B. Demonstrate operation and maintenance of the systems or equipment to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.

C. These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Provider during Functional Testing.

D. Provide the services of manufacturer representatives to assist instructors where necessary.

END OF SECTION

SECTION 26 0913
POWER MONITORING AND CONTROL SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Power monitoring and control system is defined to include, but is not limited to, remote devices for monitoring and communication interface hardware.

1.02 RELATED SECTIONS AND WORK

A. Refer to the One-Line Diagram for rating, location and configuration.

1.03 REFERENCES

A. ANSI C12 - Code for Electrical Metering

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Provide product data showing the type, size, rating, catalog number, manufacturer's names, and/or data sheets for all items to ensure compliance with these specifications. Submit operation and programming manual.

C. Submit shop drawings of the complete layout of the entire system, showing wiring and all equipment.

1.05 REGULATORY REQUIREMENTS

A. System: UL listed.

1.06 SYSTEM DESCRIPTION

A. The power monitoring and controls (PMCS) shall consist of electronic power monitoring devices as designated on the project drawings and described herein. The system shall be capable of monitoring, displaying, logging, and communicating the true RMS measurements in this specification as a minimum level of performance. The system shall be designed so the maximum response time from an event or reading to displaying shall be 10 seconds.

B. Minimum accuracy of readings shall be:

1. Frequency ± 0.01 Hz.
2. Current and voltage ± 0.5% of reading.
3. Energy ± 1% of reading.

1.07 PROJECT RECORD DOCUMENTS

A. Provide installation and maintenance manuals under provisions of Section 26 0500. Include name, address and telephone number of service location within 100 miles of project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Square D - POWERLOGIC and ION Enterprise

B. Eaton Power Xpert

C. ABB

D. Siemens

2.02 POWER MONITORING DEVICES INSTALLATION

A. All metering devices, electronic trip units shall be installed by the equipment manufacturer for all circuits as indicated by the project drawings.

B. All control power, CT, PT, and data communications wire shall be factory wired and harnessed within the equipment enclosure. Where external circuit connections are required, terminal blocks shall be provided, and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type to be used.

C. Provide control transformers, current transformers, and fused potential transformers sized as required.

2.03 POWER MONITORING DEVICE CHARACTERISTICS

A. DPM; Power Meter:

1. The following instantaneous readings shall be monitored, displayed, by the power meter:
    a. Frequency, monthly maximum and minimum
    b. Current, per phase RMS, 3-phase average RMS, apparent RMS, peak demand (15-minute sliding window)
    c. Voltage, phase-to-phase and phase-to-neutral
    d. Power factor, per phase and 3-phase total
    e. Real power (kW), 3-phase total, peak demand, cumulative (kWH)
    f. Reactive power (kVAR), 3-phase total
    g. Total harmonic distortion (current and voltage)
2. The current and voltage signals shall be digitally sampled at a rate high enough to provide true-RMS sensing through the 31st harmonic. All setup parameters required by the power meter shall be stored in nonvolatile memory and retained in the event of a control power interruption. The meter shall maintain, in nonvolatile memory, maximum and minimum values for each of the instantaneous values reported, as well as the time and date of the highest peak for all peak demand readings.
3. The power meter shall be equipped with a display to provide local access to all metered quantities.
4. Reset of the following electrical parameters shall also be allowed from the front of the display or energy meter:
    a. Peak demand current
    b. Peak demand power
    c. Energy (MWH)
    d. Reactive energy (MVARH)
5. Waveform Capture Capability: Waveform capture shall be for three (3) cycles and initiated manually using software.
6. The data points shall be sampled in a manner that allows the original power signals with proper magnitude and phase relationships to be reconstructed. Reconstruction of the original power signal from the stored data points shall have sufficient accuracy to allow steady-state power harmonic analysis that provides valid information on harmonic content for up to the 81st harmonic of the fundamental power frequency.
7. The power meter shall have one (1) digital input and one (1) digital solid state output/KY pulse output.
8. The power meter shall be provided with a six (6) digital input and two (2) digital output (relay) output accessory card.
9. Manufacturers:
    a. Square D Power Logic PM820
    b. Eaton
    c. Siemens PAC4200
    d. ABB M4M Series

B. Electronic Trip Units:

1. Electronic trip units shall be provided as designated on the project drawings.

2. They shall provide the following breaker/trip unit information to the PMCS network:
   a. Breaker sensor rating
   b. Rating plug
   c. Date/time of last trip
   d. Type of last trip (overload, short circuit, ground fault)
   e. Magnitude of phase and ground fault at time of last trip
   f. Number of overload trips
   g. Number of short circuit trips
   h. Number of ground fault trips
3. The electronic trip units designated P in the one-line diagram shall provide equivalent information to the digital power meter specified above. The electronic trip units designated H in the one-line diagram shall provide equivalent information to the power quality meter specified above.

2.04 SYSTEM DISPLAY UNITS

A. System display units shall be provided to display the data available from selected electronic trip units connected on the individual data transfer network.

B. The system display unit shall utilize a 4 line by 20 character, high contrast display with backlighting. The level of backlighting as well as the contrast shall be adjustable.

C. The system display shall be equipped with a screen saver feature to extend the life of the display.

D. Data shall be displayed in a logically organized manner, complete with the proper scaling and units.

E. The system display unit shall allow for easy operation by providing a keypad with large keys for operator selections. The keys shall have a raised perimeter and tactile feedback to provide a positive response, even with gloved-hand operation.

F. The keys shall be clearly marked to indicate the function and separated into meaningful groups, with display prompting to assist the user in operation.

G. Each system display unit shall be configured by the manufacturer with all necessary data. It shall be possible to change the configuration for each system display unit using the keypad provided on each display. Access to configuration functions shall be password protected to prevent unauthorized or accidental modification.

H. The system display unit shall permit the reset of the stored min-max values in the power monitoring devices. It shall also permit the reset of the accumulated energy values and the time and date stamps stored in the metering devices. These resets shall be limited to authorized persons by means of password protection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type to be used.

B. All wiring required to externally connect equipment lineups shall be installed by the Electrical Contractor.

3.02 STARTUP AND TRAINING

A. The power monitoring manufacturer shall provide a full-time telephone technical help center for customers.

END OF SECTION

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SECTION 26 0933
LIGHTING CONTROL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Line and low voltage standalone lighting controls

1.02 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 51 19 LED Lighting
2. 26 52 15 Emergency Lighting Inverter
3. Electrical Drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.03 RELATED WORK

A. Section 01 9100 - Commissioning

B. Section 23 0900 - Facility Management Control System (FMCS)

C. Section 26 5100 - Lighting

1.04 QUALITY ASSURANCE

A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required.

B. All components and assemblies are to be factory pre-tested prior to delivery and installation.

C. Comply with Electrical Code as applicable to electrical wiring work.

D. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

E. Panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Panels and accessories used for control of life safety and critical branch circuits shall be listed under UL 924 Emergency Lighting and Power Equipment.

F. All assemblies are to be in compliance with FCC emissions standards specified in Part 15 Subpart J for Class A applications.

1.05 REFERENCES

A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

B. FS W S 896 Switch, Toggle

C. International Energy Conservation Code (IECC)

D. NEMA WD 1 - General Color Requirements for Wiring Devices

E. NEMA WD 7 - Occupancy Motion Sensors

F. NFPA 70 - National Electrical Code (NEC)

G. UL Standard 916 Energy Management Equipment

H. UL 924 - Emergency Lighting and Power Equipment

I. UL 1472 - Solid-State Dimming Controls

1.06 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements, and roles and responsibilities of all persons and groups involved in installation, execution, and commissioning.

C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

D. Submit a list of devices and equipment that will be installed for each sequence of operation.

E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, occupancy sensors, control stations, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.

F. Verify acceptance of communications connection to building automation system. Submit BACnet IP parameters.

1.07 EXTRA STOCK

A. Provide extra stock under provisions of Section 26 0500.

B. Sensors, Controls, Power Supplies, and Relays: Five (5) percent of quantity installed. Minimum of two (2) of each configuration and type.

C. Relays and Dimmer Modules: Five (5) percent of quantity installed. Minimum of two (2) of each size and type.

D. Control Stations: One (1) of each configuration and type, except for LCD touch screens requiring factory setup prior to installation.

1.08 PROJECT RECORD DOCUMENTS

A. Submit project record documents under provisions of Section 26 0500.

B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit emergency, operation, and maintenance data under provisions of Section 26 0500. Data shall also include the following:

1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
3. Replacement part numbers for all system components.

B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.

C. Submit software operating and maintenance manuals, program software backup on compact disc or compatible media with data files, device address list, and a printout of software application and graphic screens, where applicable.

1.10 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system (LCS). These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.

B. Provide an integrated lighting controls system consisting of panels, power supplies, controllers, sensors, relays, switches, devices, wiring, etc. necessary to perform the Lighting Control Sequence of Operation as defined on the plans and specifications. Contractor is responsible for confirming that all components and luminaires interoperate as a single system.

1. Sequence of Operation: Describes the required operation and performance for lighting control in each space. Sequences of operation are indicated on the drawings.
2. Drawings: The drawings include sequences of operation, locations of control interface devices, sensors, and control zones. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted with the shop drawings.

C. The following control types and features are acceptable. Acceptable control locations are shown on the drawings.

1. Line Voltage Control: Control equipment consists of traditional line voltage wiring devices and equipment such as switches, dimmers and combination occupancy/vacancy sensor switches, etc.
2. Distributed Control: Control equipment is in the space/zone being controlled; not reliant on centralized controllers.
    a. All locations shall have the ability to be networked for remote control and monitoring.
3. Centralized Control: Control equipment is in a central location serving multiple spaces/zones and provides time-based schedule and remote control.
    a. The lighting control system (LCS) shall be networked with BACnet IP capabilities.
    b. The lighting control system (LCS) shall have DMX512 capabilities.
4. Wireless Control: Equipment that uses radio frequency to transmit lighting control signals.

1.11 COMMISSIONING

A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 1 for detailed commissioning requirements.

B. The Contractor shall provide all services necessary for compliance with the IECC Section C408 Commissioning. The commissioning shall include, but not be limited to, a commissioning plan, preliminary commissioning report, construction documents, manuals, final commissioning report, and lighting system functional testing.

C. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning. The commissioning process, equipment, and systems to be commissioned are defined in Division 1.

D. The Contractor shall notify the Commissioning Agent, Architect/Engineer and Owner's Representative ten (10) working days prior to scheduled commissioning date.

E. The commissioning process requires meeting attendance. Refer to Division 1 for meeting requirements.

F. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

1.12 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.

B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 LIGHTING CONTROLS

A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications. Lighting control switches, systems, and components shall be listed.

B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.

C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.

2.02 DEVICE COLOR

A. All switch, lighting controls, and coverplate colors shall be the same as wiring devices, unless indicated otherwise.

2.03 COVERPLATES

A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 0553.

D. Plate-securing screws shall be metal with head color matching the wall plate finish.

2.04 WALL SWITCHES

A. Refer to Electrical Symbols List for device type.

B. Switch touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi. Coverplate color shall match the switch color.

1. Manufacturers:
    a. Cooper 7621 CuVerro
    b. Leviton A5621
2. Install antimicrobial switches and cover plates in following departments:
    a. ICU, NICU, OR, Cath Lab

C. SW-1P; Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
2. Manufacturers:
    a. Hubbell HBL1221
    b. Leviton 1221-2
    c. Pass & Seymour PS20AC1
    d. Cooper AH1221
3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:
    a. Hubbell DS120
    b. Leviton 5621

c. Pass & Seymour 2621
d. Cooper 7601.

D. SW-3W; Three-way Switch:
1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:
a. Hubbell 1223
b. Leviton 1223-2
c. Pass & Seymour PS20AC3
d. Cooper AH1223
3. 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.
4. Manufacturers:
a. Hubbell DS320
b. Leviton 5623
c. Pass & Seymour 2623
d. Cooper 7623

2.05 WALL DIMMERS

A. UL listed with integral air-gap switch for on/off control.
B. Integral EMI/RFI suppression.
C. Non-viewable heat sink.
D. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.
E. Dimmer to match device color.
F. SW-D-LED; LED Electronic Driver Dimmer:
1. 277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60629 Annex E.
2. Manufacturers:
a. Compatible with provided LED driver.
G. SW-D3-LED; LED Electronic Driver Three-Way Dimmer:
1. 277-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60929 Annex E.
2. Manufacturers:
a. Compatible with provided LED driver.

2.06 LOCAL DAYLIGHTING CONTROLS

A. SW-LS-PC; Standalone Exterior Photo Sensors:
1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.
2. Sensor shall contain an integral switching contactor rated for 277-volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero-crossing closure to provide 100,000 cycle minimum operation.
3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.

4. Sensor shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:
    a. Ambient sensitivity range of 5 to 1,500 foot-candles.
    b. Adjustable setpoint.
    c. Deadband adjustment by percentage of setpoint.
    d. Time delay of up to five minutes.
5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.
6. Manufacturers:
    a. Paragon
    b. Tork
    c. Intermatic

2.07 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Vacancy sensors require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by Electrical Code.
4. Mounting:
    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
    c. Time Delay and Sensitivity Adjustments: Recessed and concealed.
5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Power Supply and Child Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
10. Warranty: Five (5) year warranty.

B. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic or acoustic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. SW-OC-D; 360 Degree Coverage Pattern:
    a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay, integrated isolated relay contact. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: ambient sensor 40 FC.

b. Manufacturers:
1) Watt Stopper DT 300 Series
2) Hubbell OMNI-DT2000 or ATD2000C
3) Greengate OAC-DT
4) Leviton OSC##-MOW
5) Sensor Switch CM PDT 10

2. SW-OC-D-W; Wall Mounted on Adjustable Swivel Mount:
a. Wall or ceiling sensor with adjustable settings to allow manual on/auto off or auto on/auto off. Integrated ambient light level sensor (2 to 100 FC range).
b. Manufacturers:
1) Watt Stopper DT-200 Series
2) Hubbell LODTRP
3) Leviton OSM12--M series
4) Sensor Switch WvPDT 16 Series

3. Sensitivity Adjustment: Separate for each sensing technology.
4. Detection Coverage:
a. Task Areas: Detect occupancy anywhere in an area based on hand motion.
b. Circulation Areas: Detect occupancy anywhere in an area based upon half-step walking motion.

C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.
D. PIR Type: Detect occupancy by sensing a combination of heat and movement in area of coverage.
1. SW-O; Wall Switch Occupancy Sensor:
a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (10 to 150 FC range), adjustable sensitivity and time delay, no minimum load requirements, manual or auto on operation, Initial settings: 10 minutes, ambient sensor 40 FC.
b. Manufacturers:
1) Watt Stopper PW-100 Series
2) Sensor Switch WSX
3) Hubbell LHIRS1 or AP1277
4) Leviton ODS15
5) Greengate OSW-P-0451

2. SW-OC-P-P; Ceiling Mounted - 360 Degree Coverage Pattern:
a. Passive infrared, zero crossing circuitry, integrated ambient light sensor (4 to 190 FC Range), adjustable sensitivity and time delay, integral isolated relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.
b. Manufacturers:
1) Watt Stopper CI Series
2) Sensor Switch CM-9
3) Hubbell Automation Omni-IR
4) Leviton OSC Series
5) Greengate OMR-P Series

3. With daylight filter and lens to afford coverage applicable to space to be controlled.

E. Ultrasonic Type: Ceiling mounting. Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. SW-OC-U; 360 Degree 20' x 20' Hand Motion Coverage Pattern:
    a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated 1-amp relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
    b. Manufacturers:
        1) Watt Stopper WT-1100 series
        2) Hubbell OMNI-US or ATU series
        3) Leviton OSC series
        4) Greengate ODC-U series
2. SW-OC-U-A; 360 Degree Two-Sided Corridor Coverage Pattern:
    a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
    b. Manufacturers:
        1) Watt Stopper WT-2250 Series
        2) Hubbell OMNI-US or ATU series
        3) Greengate ODC-U Series
3. Crystal controlled with circuitry that causes no detection interference between adjacent sensors.

2.08 DISTRIBUTED LIGHTING CONTROL

A. Manufacturers: as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. Acuity Controls nLight Series
2. Legrand Watt Stopper DLM Series
3. Hubbell Automation NX Series
4. Eaton Greengate RC3 Series (room-based system)
5. Osram Encelium Series
6. Lutron

B. System Description: The lighting control system shall be a network of remote modules. System includes all associated wiring, relay modules, photocells, switches, dimmers, time clock, occupancy sensors. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.

C. Control Devices: All occupancy sensors (ultrasonic, IR and dual technology type), photocells, switches, and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

D. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277-volt wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to four (4) relays. Relay modules shall be labeled with room number that relays control lighting within.

E. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, 50,000 cycles at rated capacity.

F. Network Hub: Network Hub shall contain processor and astronomic time clock for control and monitoring of lighting. Network hub shall be fed from an equipment emergency circuit at a minimum.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION MEETING

A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control centralized, wireless, and distributed systems.

3.02 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings.

B. All wiring shall be installed in conduit. Class II low voltage control wiring may be open wiring and shall maintain 150 mm (6 inch) spacing from electronic ballast and other RFI/EMI sources.

C. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

3.04 SUPPORT SERVICES

A. System Startup:

1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.

B. Testing:

1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.

2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming, However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:

   a. Confirm occupancy sensor placement, sensitivity, and time delay settings to meet specified performance criteria.

   b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.

   c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.

3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.

4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.
    a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
    b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.

C. Training:
1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.
2. Training duration shall be no less than three (3) days, with one (1) day being scheduled at least two (2) weeks after initial training.

D. Documentation:
1. Manufacturer shall provide system documentation including:
    a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or BMS/BAS interface unit.
    b. Drawings for each panel showing hardware configuration and numbering.
    c. Panel wiring schedules.
    d. Typical diagrams for each component.

3.05 SYSTEM COMMISSIONING

A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 0900, General Commissioning, for further details.

B. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 0900, General Commissioning, for system verification tests and commissioning requirements.

C. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 0900, General Commissioning, for Contractor training requirements.

END OF SECTION

SECTION 26 2200
DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Dry type two winding transformers (TR-#)

1.02 REFERENCES

A. NEMA - ST 1 - Specialty Transformers

B. NEMA ST 20 - Dry Type Transformers for General Applications

C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers

D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers

E. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.

F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

1.03 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 26 0500.

B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.

C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.01 DRY TYPE TWO WINDING TRANSFORMERS

A. Acceptable Manufacturers:

1. Square D 7400 EX##T / SK300##KB Series
2. Eaton V48M / H48M / B48M Series
3. ABB 9T Series
4. Hammond SG / SMK Series
5. Siemens 3F3 Series

B. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

C. Insulation system and average winding temperature rise for rated KVA as follows:

D. Case temperature shall not exceed 40°C rise above ambient at its warmest point.

E. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

F. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.

G. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
Equivalent Winding kVA Range	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

I. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

J. Coil Conductors: Continuous windings with terminations brazed or welded.

K. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.

L. Isolate core and coil from enclosure using vibration-absorbing mounts.

M. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Set transformer plumb and level.

B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

C. Mount transformers on four 3”x3”x1/2” thick, 50 durometer rubber vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Ventilated transformers: Provide factory label on horizontal surface to prohibit storage on top, front, or adjacent to transformer.

3.02 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

END OF SECTION

SECTION 26 2416
PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Service and distribution panelboards: DP-#

B. Lighting and appliance branch circuit panelboards: Panel '###'

1.02 RELATED SECTIONS AND WORK

A. Refer to the Electrical Distribution Diagram and Electrical Schedules for size, rating, and configuration.

1.03 REFERENCES

A. NEMA AB 1 - Molded Case Circuit Breakers

B. NEMA KS 1 - Enclosed Switches

C. NEMA PB 1 - Panelboards

D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

E. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment

F. UL 67 - Panelboards

1.04 SUBMITTALS

A. Submit shop drawings for equipment and component devices under provisions of Section 26 0500.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.

E. Submit manufacturer's instructions under provisions of Section 26 0500.

1.05 SPARE PARTS

A. Keys: Furnish four (4) each to the Owner.

PART 2 - PRODUCTS

2.01 RATINGS

A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 0553 for additional requirements.

2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.02 MAIN AND DISTRIBUTION PANELBOARDS

A. General

1. Manufacturers:

a. Square D QMB, I-Line

b. ABB ReliaGear Entelleon

c. Siemens F2, P4

d. Eaton PRL4, PRL5

B. Panelboards: NEMA PB 1; type as shown on the drawings.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with concealed trim clamps and hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.

G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.

H. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

I. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

J. Arc Energy Reduction:

1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.

2.03 BRANCH CIRCUIT PANELBOARDS

A. General

1. Manufacturers:

a. Square D NQ, NF

b. ABB A Series

c. Siemens P1

d. Eaton PRL1, PRL2

B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.

J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.

B. Height: 6 feet to handle of highest device.

C. Provide filler plates for unused spaces in panelboards.

D. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.

3.02 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION

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SECTION 26 2419
MOTOR CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Manual motor starters

B. Magnetic motor starters

C. Combination magnetic motor starters

1.02 RELATED SECTIONS AND WORK

A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

1.03 REFERENCES

A. ANSI/UL Standard 508. Standard for Industrial Control Equipment

B. FCC Rules and Regulations, Part 15, Subpart J- Radio Frequency Interference

C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service

D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)

E. FS W-P-115 - Power Distribution Panel

F. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted

G. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters

H. NEMA AB 1 - Molded Case Circuit Breakers

I. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies

J. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

K. NEMA KS 1 - Enclosed Switches

L. NEMA PB 1 - Panelboards

M. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.

C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.

D. Submit manufacturer's instructions under provisions of Section 26 0500.

1.05 SPARE PARTS

A. Keys: Furnish four (4) each to the Owner.

B. Fuses: Furnish three (3) spare fuses of each type and rating installed to the Owner.

C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 0500.

B. Deliver in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.

C. Store and protect products under provisions of Section 26 0500.

D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.

E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.01 MANUAL MOTOR STARTERS

A. Acceptable Manufacturers:

1. Square D 2500 Series
2. Eaton MS Series
3. ABB
4. Siemens SMF/MMS Series

B. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.

C. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.

D. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.

E. Enclosure: NEMA ICS 6; Type 1.

2.02 MAGNETIC MOTOR STARTERS

A. Acceptable Manufacturers:

1. Square D
2. Eaton
3. ABB
4. Siemens
5. Franklin Control

B. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.

C. Full Voltage Starting: Non-reversing type, unless otherwise indicated.

D. Reduced Voltage Starting: Closed-circuit transition wye-delta type: NEMA ICS 2, closed transition with adjustable time delay.

E. Two Speed Starting: Two speed, one winding, variable torque type. NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.

F. Coil Operating Voltage: 120 volts, 60 Hertz, obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating, and control devices, plus 100% spare capacity.

G. Size: NEMA ICS 2; size as shown on the drawings.

H. Overload Relay:

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

I. Enclosure: NEMA ICS 6; Type 1.

J. Combination Motor Starters: Combine motor starters with disconnect switch in common enclosure. Provide with disconnecting means as indicated on drawings.

K. Auxiliary Contacts: NEMA ICS 2; two normally open, field convertible contacts in addition to seal-in contact.

L. Pushbuttons: NEMA ICS 2; START/STOP in front cover.

M. Elapsed Time Meters: Heavy duty with readout in tenths of an hour.

N. Indicating Lights: NEMA ICS 2; RUN: red in front cover.

O. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.

P. Relays: NEMA ICS 2.

Q. Control Power Transformers: 120 volt fused secondary, fused primary, minimum VA as scheduled:

1. Size 1 - 100 VA
2. Size 2 - 100 VA
3. Size 3 - 150 VA
4. Size 4 - 300 VA
5. Size 5 - 300 VA
6. Size 6 - 300 VA

R. Provide phase loss protection relay with contacts to de-energize the starter for each starter serving motors 5 HP or greater.

2.03 CONTROLLER OVER-CURRENT PROTECTION AND DISCONNECTING MEANS

A. Acceptable Manufacturers:

1. Starter manufacturer

B. Molded Case Thermal-Magnetic Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole. NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

C. Non-fusible Switch Assemblies: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Provide with Class 'R' rejection clips. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install motor control equipment in accordance with manufacturer's instructions on concrete bases.

B. Install fuses in fusible switches.

C. Select and install heater elements in motor starters to match installed motor characteristics.

D. Set field-adjustable switches and circuit-breaker trip ranges.

E. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

F. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

END OF SECTION

SECTION 26 2726
WIRING DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Device plates and box covers

B. Receptacles (REC-#)

C. Cord and plug sets

1.02 RELATED SECTIONS

A. Section 26 0538 - Underfloor Ducts.

1.03 QUALITY ASSURANCE

A. Provide similar devices from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Electrical Code, by a testing agency to Authorities Having Jurisdiction and marked for intended use.

C. Comply with the Electrical Code.

1.04 REFERENCES

A. DSCC W-C-896F - General Specification for Electrical Power Connector

B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet

C. NEMA WD 1 - General Color Requirements for Wiring Devices

D. NEMA WD 6 - Wiring Devices - Dimensional Requirements

E. NFPA 70 - National Electrical Code (NEC)

F. UL 498 - Standard for Attachment Plugs and Receptacles

G. UL 943 - Standard for Ground Fault Circuit Interrupters

1.05 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

C. Provide a non-returnable sample of each countertop and furniture-mounted receptacle assembly as part of the submittal process.

1.06 COORDINATION

A. Receptacles for Owner Furnished Equipment: Match plug configurations.

B. Cord and Plug Sets: Match equipment requirements.

C. Coordinate installation of receptacle assemblies in countertops and furniture with the Contractor providing the countertop or furniture. Contractor shall coordinate penetrations and conduit routing in countertops and furniture with drawings and other obstacles below the installation surface.

PART 2 - PRODUCTS

2.01 DEVICE COLOR

A. All switch, receptacle, and outlet colors shall be verified with Architect, unless indicated otherwise.

2.02 COVERPLATES

A. All switches, receptacles, and outlets shall be complete with the following:

1. #302 stainless steel coverplates in finished spaces where walls are finished.
2. #302 stainless steel coverplates in unfinished spaces for flush boxes.
3. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 0553.

D. Plate securing screws shall be metal with head color matching the wall plate finish.

2.03 RECEPTACLES

A. Refer to Electrical Symbols List for device type.

B. Devices that are shaded on the drawings shall be red.

C. Devices that are shaded on the drawings shall be red and shall have an illuminated face or indicator light to indicate that there is power to the device.

D. REC-DUP: NEMA 5-20R Duplex Receptacle:

1. Heavy Duty: 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap with integral ground contacts.
    a. Manufacturers:
        1) Hubbell 5362
        2) Leviton 5362
        3) Pass & Seymour 5362A
        4) Cooper AH5362

E. REC-DUP-GFI: NEMA 5-20R Ground Fault Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
    a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
    b. Manufacturers:
        1) Hubbell GFCI type devices are not allowed. Contractor may substitute an alternative manufacturer when Hubbell is the basis of submittal for all other wiring devices.
        2) Leviton GFNT2
        3) Pass & Seymour 2097
        4) Cooper SGF20

F. REC-DUP-WP: NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, weather resistant WR listed. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
    a. Manufacturers:
        1) Hubbell:
            a) GFTWRST20 with aluminum housing WP826
            b) GFCI type devices are not allowed. Contractor may substitute an alternative manufacturer when Hubbell is the basis of submittal for all other wiring devices.
        2) Leviton GFWT2 with aluminum housing M5979
        3) Pass & Seymour 2097TRWR with aluminum housing WIUCAST1
        4) Cooper WRSGF20 with aluminum housing WIUMV-1

G. REC-SIM-520R: NEMA 5-20R Simplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face.
    a. Manufacturers:
        1) Hubbell HBL5361
        2) Leviton 5361

3) Pass & Seymour 5361
4) Cooper 5361

H. REC-SIM-530R: NEMA 5-30R Simplex Receptacle:
1. 125-volt, 30 amp, 3-wire grounding type, phenolic face.
a. Manufacturers:
1) Hubbell HBL9308
2) Leviton 5371
3) Pass & Seymour 3802
4) Cooper 5716N

I. REC-SIM-620R: NEMA 6-20R Simplex Receptacle:
1. 250-volt, 20 amp, 2-pole, 3-wire grounding type with thermoplastic face.
a. Manufacturers:
1) Hubbell HBL5461
2) Leviton 5461
3) Pass & Seymour 5871
4) Cooper 5461

J. REC-SIM-1530R: NEMA 15-30R Simplex Receptacle:
1. 250-volt, 30 amp, 3-phase, 3-pole, 4-wire grounding type with thermoplastic face.
a. Manufacturers:
1) Hubbell HBL8430A
2) Leviton 8430
3) Pass & Seymour 5740
4) Cooper 8430N

K. REC-SIM-L520R: NEMA L5-20R Simplex Receptacle, Locking Type:
1. 125-volt, 20 amp, 2-pole, 3-wire grounding type with impact resistant thermoplastic face.
a. Manufacturers:
1) Hubbell
2) Leviton
3) Pass & Seymour L520
4) Cooper CWL520R

L. REC-QUAD: NEMA 5-20R Double Duplex Receptacle:
1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
a. Manufacturers:
1) Refer to Duplex Receptacle above.

M. REC-QUAD-GFI: NEMA 5-20R Double Duplex GFI Receptacle:
1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.
a. Manufacturers:
1) Refer to Duplex GFI Receptacle above.

N. REC-QUAD-WP: NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:
   1. Consists of two duplex, GFI receptacles. Double gang box. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
      a. Manufacturers:
         1) Receptacle: Refer to GFCI Receptacle above.
         2) Cover:
            a) Intermatic WP1030MXD
            b) Pass & Seymour WIUCAST2
            c) Thomas & Betts Red Dot 2CKU

O. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

P. Side wired devices shall have four binding screws that are undercut for positive wire retention.

Q. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

2.04 FLOOR BOXES

A. Cover Color and Style: Verify with Architect from manufacturer standard options.

B. Refer to Technology drawings for voice/data, Audio/Video outlet, and coordination requirements.

C. Floor Boxes Housing Material Based on Cast-in-Place Floor Type:
   1. Slab on Grade: Cast Iron or listed for slab on grade with special kit, coating ,or equivalent; corrosion resistant.

D. FB-1: Round Flush with Finished Floor:
   1. Floor Box, round, round flush-mounted hinged cover with flange, provide complete with appropriate outlet cover plates and hardware, for use with4-inch minimum concrete pour floors, fully adjustable.
   2. Gang / Outlet Descriptions:
      a. Power furniture/equipment feed with flexible whip and 1-inch conduit.
   3. Manufacturers:
      a. Cast:
         1) Hubbell 2503 Series
         2) Legrand Wiremold 880 Series
         3) ABB Steel City 600 Series
   4. Installation: Group route raceway conduits under slab on grade or in elevated slab to nearest wall. Route conduits to nearest wall or as shown on drawings. Provide hub reducers when applicable.

2.05 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.

B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.

C. Ground Fault Protection: Provide ground fault protection for all branch circuit breakers serving 120/208 receptacle outlets rated 21 - 50 amps single phase and 21-100 amps three phase in the following locations, as shown on drawings, or required by adopted code:

1. Bathrooms, locker rooms, shower rooms
2. Kitchens
3. Rooftops
4. Interior/Exterior locations subject to damp/wet conditions
5. When located within 6 feet of sinks, bathtubs, and shower stalls

D. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.

E. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

F. Install devices and wall plates flush and level.

G. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 0553 - Electrical Identification.

H. Test receptacles for proper polarity, ground continuity and compliance with requirements.

I. Floor Box Installation:

1. Set boxes level and flush with finish flooring material.
2. Use cast iron floor boxes for installations in slab on grade. Trim shall match floor covering to be used.
3. Provide a minimum horizontal offset of 24 inches between boxes.
4. Provide saw-cutting and patching of existing concrete floors as necessary for floor box installations within existing floors.

END OF SECTION

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SECTION 26 2813
FUSES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fuses

1.02 REFERENCES

A. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Types

B. UL 198E - Class R Fuses

C. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)

D. NEMA FU 1 - Low Voltage Cartridge Fuses

E. NFPA 70 - National Electrical Code (NEC)

1.03 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

1.04 EXTRA MATERIALS

A. Provide three of each size and type of fuse installed.

1.05 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40°F or more than 100°F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS - FUSES

A. Bussman, Division of Eaton

B. Edison Fuse, Division of Cooper Industries

C. Mersen

D. Littelfuse Inc

2.02 FUSES

A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.

B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.

C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.

D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.

E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.

F. Control transformer fuses: Class CC (time delay).

G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install fuses where indicated on the drawings and specifications.

B. Install fuses in accordance with manufacturer's instruction.

C. Install fuses in packaged equipment as required by equipment manufacturer.

D. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

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SECTION 26 2816
DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fusible switches

B. Non-fusible switches

C. Enclosures

1.02 RELATED SECTIONS AND WORK

A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.03 REFERENCES

A. NEMA KS 1 - Enclosed Switches

1.04 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.

C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.05 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Acceptable Manufacturers:

1. Square D 3110 Series
2. Eaton DH Series
3. ABB TH Series
4. Siemens HNF / HF Series

B. FDS-#; Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.

C. DS-#; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

D. Enclosures: Type as indicated on the disconnect schedule.

E. Accessories: As indicated on the disconnect schedule.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.02 ADJUSTING

A. Set field-adjustable circuit breaker trip ranges.

END OF SECTION

SECTION 26 2923
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable frequency drives (VFD-#)

1.02 RELATED SECTIONS AND WORK

A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

B. Divisions 21, 22, 23 - Fire Protection, Plumbing, and Mechanical when referenced.

1.03 REFERENCES

A. ANSI/UL Standard 508

B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems

C. IEEE Standard 519-2014 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters

D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

C. Product Data: Provide catalog sheets showing PWM configuration (6, 12, 18 pulse, Active Front End AFE), voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

D. Product Data for Accessories and Options: Provide catalog sheets showing voltage, dimensions, ratings, for accessories and options. Include information for passive harmonic filters, active harmonic filters, line reactors, shielded VFD cabling, output filters, etc. as an inclusive submittal package provided by the VFD supplier. The VFD supplier shall act as a single contact of responsibility.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

F. Contractor's Letter of Acknowledgement: The contractor shall include a letter acknowledging the following with date and signature. The letter shall include a location for the installing contractor to sign the document:

1. The manufacturer/vendor received a complete copy of the design document specifications, plans, and schedules as related to the variable frequency drive requirements for the project.
2. The contractor and manufacturer have reviewed the distance relationship between the VFD location and the motor(s) served in conjunction with the installing contractors cable routing plan. The submittal includes compliance with the minimum requirements for each specific application including the addition of harmonic filters and shielded VFD cabling. The contractor is responsible for compiling and documenting information including cable lengths for mutual review with the manufacturer.
3. Leading Power Factor Management: The manufacturer has reviewed the design and identified VFD applications scheduled to operate on a generator power source.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 26 0500.

B. Accept controllers on site in original packing. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.

C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

D. Shop Drawings: For each VFD.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    a. Each installed unit's type and details.
    b. Nameplate legends.
    c. Short-circuit current rating of integrated unit.
    d. UL listing for series rating of overcurrent protective devices in combination controllers.
    e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

E. Manufacturer Seismic Qualification Certification: Submit certification that VFDs, accessories, and components will withstand seismic forces defined in Division 26 Section 26 0548 "Seismic Requirements for Equipment and Supports". Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
    b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Variable Torque Applications:

1. Toshiba Q9 Series
2. ABB ACH 580 (HVAC) / ACS 580 (other applications) Series
3. Allen Bradley PowerFlex Series
4. Danfoss VLTFC100 Series
5. Mitsubishi FR-F800 Series
6. Square D, S-Flex / ATV660 Series
7. Eaton MMX / HMX / SVX Series
8. Yaskawa Z1000 Series

B. Constant Torque Applications:
   1. Toshiba G9 Series
   2. ABB ACS 580 / 880 Series
   3. Allen Bradley PowerFlex Series
   4. Danfoss VLT5000 Series
   5. Mitsubishi FR-A800 Series
   6. Square D ATV960 Series
   7. Eaton SVX Series
   8. Yaskawa A1000 Series

C. The Variable Frequency Drive Schedule and drawings use equipment tags to define the scope of the project. The equipment tag (example: VFD-5) may be representative of multiple similar applications. Additional options and accessories may be required by the specifications and manufacturer recommendations due to the specific application but not represented in the Variable Frequency Drive Schedule. Refer to the Options, Accessories, and minimum performance requirements of this specification for a complete list of requirements (example: output filters and shielded VFD cables).

D. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule and Mechanical Schedules when applicable.

2.02 MINIMUM PERFORMANCE, REQUIRED OPTIONS, AND ACCESSORIES

A. The following minimum performance requirements, options, and accessories supplement the requirements of the Variable Frequency Drive Schedule. In the event of a conflict between the schedule and specification the most stringent requirement will be enforced.
   1. Manual Speed Adjustment
   2. Electronic Thermal Overloads
   3. Control Transformer, Fused, 120 volt. Acceptable Alternative, 120 volt / 24 volt power supply available directly from VFD, 100mA minimum.
   4. Hand-off-Auto Door Switch
   5. Skip Frequency Capability

B. Line Input Reactor: Provide all VFDs with a minimum input line reactor of (3%). The input line reactor may be integral or individually mounted.
   1. Exception: The manufacturer may substitute an LCL type harmonic filter with an input harmonic filter; an approximate equivalent (3%) impedance from the harmonic filter is anticipated.
   2. Exception: A dual (positive and negative) 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter. Exception: Not required for Active Front End AFE drives with an IGBT front end instead of a diode-bridge configuration.

C. Forced Ventilation Accessories and Operation: Provide per manufacturer requirements as required for the standard performance of the drive, the application, and environmental conditions.
   1. Provide inlet air outlet filter when a fan is provided. Provide an outlet filter if appropriate for the physical construction of the VFD.
   2. Field replaceable blower fan sized to maintain VFD at rated operating temperatures for ambient conditions of enclosure location. The VFD manufacturer's air change requirements shall be satisfied or exceeded for enclosed applications.

D. Harmonic Distortion Performance Criteria (PCC defined at VFD): The variable frequency drive shall have the following minimum harmonic distortion performance criteria; reference to the latest edition of IEEE 519. The Point of Common Coupling PCC shall be considered the input line terminals of the combination VFD, applicable filters, and accessories for the following requirements.

1. The minimum configuration represents the minimum acceptable solution to achieve THDv and TDDi performance requirements. Alternative approved solutions have been listed and shall be substituted within the scope of the original bid pricing when the minimum configuration does not satisfy the harmonic performance requirements listed.
2. Equivalent HP rating: When a single VFD is configured to serve multiple smaller motors (example: skid packaged equipment, fan wall systems) the equivalent sum of the motor HPs (VFD HP rating) shall be considered the HP rating for the following criteria.
3. VFD rating 15 HP or less:
    a. Minimum Configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
        1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent
        2) Current Total Demand Distortion (TDDi) limit: 5 percent
    b. Approved Solutions for Minimum THDv and TDDi Performance: The following approved solutions or a combination of the following is acceptable:
        1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.
        2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
        3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.
4. VFD rating exceeding 15HP to 99HP:
    a. Minimum configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
    b. Minimum Performance Criteria:
        1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent
        2) Current Total Demand Distortion (TDDi) limit: 5 percent
    c. Approved solutions for minimum THDv and TDDi performance: The following approved solutions or a combination of the following is acceptable:
        1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.
        2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
        3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.
5. VFD rating 100HP or larger:
    a. Minimum configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
    b. Minimum Performance Criteria:
        1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent
        2) Current Total Demand Distortion (TDDi) limit: 5 percent

3) IEEE 519 compliance at the drive/filter input terminals with a voltage imbalance or 3% or larger, operation at unity power factor, and dynamic braking to prevent regeneration to the supply.

c. Approved solutions for minimum THDv and TDDi performance: The following approved solutions or a combination of the following is acceptable:

1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.

2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.

3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.

E. Harmonic Distortion Performance Criteria (PCC defined at utility): The variable frequency drive shall have the following minimum harmonic distortion performance criteria, reference to the latest edition of IEEE 519.

1. The minimum configuration represents the minimum acceptable solution to achieve THDv and TDDi performance requirements. Alternative approved solutions have been listed and shall be substituted within the scope of the original bid pricing when the minimum configuration does not satisfy the harmonic performance requirements listed.

2. Equivalent HP rating: When a single VFD is configured to serve multiple smaller motors (example: skid packaged equipment, fan wall systems) the equivalent sum of the motor HPs (VFD HP rating) shall be considered the HP rating for the following criteria.

3. Harmonic Distortion Compliance Method:

a. Minimum Configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.

b. Minimum Performance Criteria: IEEE 519 latest edition compliance at the utility service Point of Common Coupling PCC. The THD shall not exceed IEEE 519 nor the following criteria, whichever is more stringent.

1) Voltage Total Harmonic Distortion (THDv) limit: 5 percent

2) Current Total Demand Distortion (TDDi) limit: 5 percent

3) Perform harmonic system analysis prior to bid. Include additional input line reactors, filters, etc. for IEEE 519 compliance with bid. Refer to Approved Solutions for minimum THDv and TDDi performance below.

c. Approved solutions for minimum THDv and TDDi performance: The following approved solutions or a combination of the following is acceptable in lieu of the minimum configuration for compliance with IEEE 519:

1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or "Ultra low harmonic drives" that do not limit the maximum motor output power at full load.

2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.

3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.

F. Existing Conditions - Performance Verification: The scope includes the addition of an existing facility.

1. Measure Pre-existing Conditions: The contractor shall use a power quality meter to measure the pre-existing THDv and TDDi conditions of the facility at the electrical service entrance. The measurement shall be performed prior to any new equipment being installed. Include results of measurements with submittals: Include the following results:

2. Measure Installed Conditions: The contractor shall use a power quality meter to measure the post-installation THDv and TDDi conditions of the facility at the electrical service entrance. The measurement study may be performed during building commissioning, . Submit with O&M documents.
3. Include the following data for each test:
    a. THDv (voltage)
    b. TDDi (current)
    c. Power Factor
    d. Maximum Demand Current IL (Amps)
4. The minimum power metering duration per test shall be: 2 days.

G. VFD Output Load Terminals - Minimum Design Requirements:
1. Provide external output line reactors, DV/DT, sine filters, and shielded VFD cable when the manufacturer™™s recommended maximum distance between the VFD and the motor(s) is exceeded.
2. Provide the following minimum design criteria in addition to manufacturer recommendations:
    a. Output line reactor (3 percent): When recommended by manufacturer.
    b. DV/DT output line reactor: VFD to motor distance exceeds 75 feet (480 volt) or 150 feet (240/208 volt).
    c. Sine Wave Output Line Reactor: VFD to motor distance exceeds 150 feet (480 Volt) or 280 feet (240/208 Volt).
    d. Shielded VFD Motor Cable: Horsepower ratings exceeds 100 HP for any cable length.

H. Leading Power Factor Management: The project includes a packaged engine emergency generator. VFD applications including a capacitor solution (example: Harmonic Filters) shall include provisions to disconnect or step control the capacitor components when the associated motor load is not operating to prevent a leading power factor while operating on the generator power source.

2.03 VFD DESCRIPTION, RATINGS, DESIGN

A. Pulse Width Modulated (PWM) Variable Frequency Drives:
1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC motors. The controller shall be suitable for use with standard inverter duty motors without requiring any modifications to the motor or the drive.
2. Drives shall be capable of use with commercially available Internal Permanent Magnet (IPM) motors up to 12 poles.
3. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz.
    a. 50HP applications and less: If derating of the inverter is necessary to run at 8kHz, then the unit™™s derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.

B. Active Front End (AFE) Variable Frequency Drives:
1. Active Frond End (AFE) variable frequency drive with an Insulated Gate Bipolar Transistor (IGBT) based front end and LCL filter to mitigate switching noise. The AFE shall allow for regenerative power flow unless associated with a distribution system using a packaged engine generator.

C. Short Circuit Current Rating SCCR Default: 100 KA. Provide integral circuit breaker or fuse switch with disconnect switch when required to achieve rating.

D. Drive and controller shall be capable of continuous full load operations throughout the following specified environmental operating conditions. Drive shall be capable of operation in the 'forward' and 'reverse' direction.
   1. Operating Ambient Temperature: 0°C to 40°C.
   2. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
   3. Minimum Elevation without Derating: 3300 feet.
   4. The VFD shall incorporate a protective coating on the main control board to conform to IEC60721-3-3 class 3C2 levels.

E. Input Voltage Performance: The drive shall provide full rated output from a line voltage range of -15 / +10% nominal voltage.

F. Controller shall have the functional components listed below:
   1. Door interlocked input circuit breaker/fused switch.
   2. Input rectifier section to supply fixed DC bus voltage.
   3. Smoothing reactor or choke for DC bus.
   4. DC bus capacitors.
   5. Control transformer or switch mode powered from all three phases.
   6. Separate terminal blocks for power and control wiring.
   7. Terminal block for operator controls.
   8. Sine weighted PWM generating inverter section.

G. Enclosure Fabrication:
   1. Enclosure: NEMA 250, Type 1, unless otherwise specified.
   2. Finish: Manufacturer's standard enamel.
   3. Devices shall be factory installed in controller enclosure and functionally tested unless otherwise indicated.

H. Displays: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current). Include meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (VDC).
   9. Set-point frequency (Hz).
   10. Motor output voltage (V).

I. Status Indication Door-mounted display shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.

5. Overcurrent.
6. External fault.

J. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

K. Panel-Mounted Operator Station or KeyPad, Start-stop, auto-manual selector switches with manual speed control potentiometer, and elapsed time meter: NEMA ICS 2, heavy-duty type.

L. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

M. Control Relays: Auxiliary and adjustable time-delay relays.

N. Protection:
1. Input transient protection by means of surge suppressors or equivalent protection.
2. Snubber networks to protect against malfunctions due to system transients.
3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
4. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
5. Motor thermal overload relay(s) adjustable and capable of NEMA Class 10 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
6. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination. Skip frequency feature is acceptable.
7. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection (fuses or circuit breaker).
11. Motor overtemperature fault.
12. Loss of load protection.

O. For a fault condition other than an internal fault, an auto restart function shall provide up to 10 programmable restart attempts. The programmable time delay before each restart shall range from 0 to 10 seconds.

P. The deceleration ramp of the controller shall be programmable for normal and fault conditions. Stop modes shall include: DC injection braking, controlled deceleration to stop and coast to stop.

Q. Upon loss of the analog speed reference signal the following shall be selectable:
1. The VFD follows the programmed deceleration ramp to a controlled stop.
2. The VFD holds the speed based upon the last good value and trigger a warning alarm.

R. The VFD operates at a pre-determined frequency (user programmable).

S. STOP key on the keypad shall be functional at all time, drive mode insensitive.

T. The VFD shall be insensitive to input power phase sequence. Input phase loss detection shall be available.

U. The output frequency shall be parameter setting enabled to fold back when the motor is overloaded (stall prevention).

V. For pump applications, the VFD shall incorporate a forward/reverse pump start sub-routine to assist with clogging.

W. An optional real time clock feature shall be available, which must facilitate the time stamping of any drive trip messages.

X. The VFD shall monitor the main circuit capacitors, control circuit capacitor, in-rush suppression circuit, and cooling fan and shall provide a pre-alarm so that maintenance can be scheduled.

Y. The VFD shall include an output timer function so that peripheral equipment maintenance can be scheduled.

Z. The VFD shall include parameter selectable input and output phase loss protection.

AA. The VFD basic insulation level shall be tested based upon ANSI/IEEE C62.41-1999.

BB. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.

CC. Minimum Efficiency at Full Load: 96 percent.

DD. Overload Capability: 1.1 times the base load current for 60 seconds every 10 minutes; 1.3 times the base load current for 2 seconds every minute.

EE. Starting Torque: 100 percent of rated torque or as indicated.

FF. Speed Regulation: Plus or minus 1 percent with no motor derating.

GG. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.

HH. The drive shall provide self-protection when the load is lost or disconnected without damage to the drive.

II. Acceleration Rate Adjustment: 0.5 - 30 seconds.

JJ. Deceleration Rate Adjustment: 1 - 30 seconds.

KK. Minimum Adjustment Range for the Output Frequency shall be: 0 to 90 Hertz.

LL. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.

MM. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.

NN. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.

OO. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.

PP. Provide adjustable skip frequencies on the drive output (minimum of three ranges).

QQ. Automatic Reset/Restart: Attempts up to 10 restarts after controller fault, on return of power after an interruption, or on undervoltage fault, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load (coasting motor re-start).

RR. Excitation Control will regulate motor output voltage based on torque requirement. Must be able to provide full motor torque when necessary across the operating speed range.

SS. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

TT. Control Transformer: Provide control power transformer for control, 120 volt secondary, fused.

UU. Control Signal Interface:

1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
    a. 0 to 10-V dc.
    b. 0-20 or 4-20 mA.
    c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs.
e. RS485.
f. Ethernet.
g. Keypad display for local hand operation.

3. Output Signal Interface:
   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.
5. The control power for the VFD digital inputs and outputs shall be 24Vdc, selectable to sink or source. Optional 120Vac control power for the digital inputs and outputs shall be available.
6. The drive control board shall be capable of operating from an independent 24V dc power supply.
7. All logic connections shall be furnished on a removable terminal strip.
8. External devices shall be able to be connected to the terminal strip for starting/stopping the VFD, speed control and indicating operation status.
9. Speed command input shall be by means of:
   a. Keypad.
   b. Analog input.
   c. Serial communications.
   d. Ethernet communications.

VV. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 0900. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.

WW. Control:
1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door or keypad.
2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.

4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass to direct-on-line operation. In this mode the thermal overload relay for the motor must be disabled.

XX. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

YY. Convertible Auxiliary Contacts (additional): Provide two additional convertible normally open / normally closed contacts.

ZZ. Electronic Thermal Overloads: Provide adjustable electronic type thermal overloads. Size protection per motor nameplate data.

AAA. Multiple Motor Thermal Overloads: Provide manual starter disconnect switch with electronic thermal overloads for each individual motor when the VFD is scheduled to server multiple motors. Size protection per motor nameplate data.

2.04 OPTIONS AND ACCESSORIES - DESCRIPTIONS

A. Passive Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating.
   1. When required:
      a. As required to satisfy, the Harmonic Distortion Performance Criteria descripted in Part 2 of this specification.
      b. Per VFD schedule.

B. Active Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating. Provide all VFDs coupled with an Active Harmonic Filter with a minimum three percent (3%) input line reactor; or larger per manufacturer requirements.
   1. When required:
      a. As required to satisfy, Harmonic Distortion Performance Criteria descripted in Part 2 of this specification.
      b. Per VFD schedule.

C. Active Bridge Rectifier Stage: Capable of limiting current harmonic distortion at the drive input terminals.
   1. When required:
      a. As required to satisfy, Harmonic Distortion Performance Criteria descripted in Part 2 of this specification.
      b. Per VFD schedule.

D. Dynamic Braking: The VFD shall incorporate terminals for adding an external braking unit to allow for dissipation of excessive electrical energy from the motor. Provide dynamic braking with load resistor or DC injection braking to provide a means of rapid deceleration of the AC motor within one (1) minute. Adjust the controls to stop the motor within 30 seconds.
   1. When required:
      a. 100HP or larger applications.
      b. VFD served by package engine generator.
      c. Per VFD schedule or other portions of this specification.
      d. All VFDs supplied for fan applications when VFD is not capable of capturing a free spinning load without damage to the VFD or motor.
   2. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds. The following options shall be available:
      a. Adjustable operation frequency, time, and voltage.

b. External line regeneration.

c. Shared DC bus capability systems for multiple drive regeneration.

E. Three-Contactor Manual Bypass:

1. When required: Per VFD schedule.

2. Provide contactors, motor running overload protection, under-voltage and loss of phase protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch or third contactor to allow maintenance of inverter during bypass operation.

3. All bypass circuitry shall be located within the same enclosure as the variable frequency drive.

4. All fire alarm and/or smoke control interconnections (e.g., air handling unit shutdown) shall apply regardless of whether control is through VFD or bypass.

5. Provide a Drive-Bypass Selector Switch.

6. When operating in bypass mode, the main power supply to the VFD shall be disconnected and isolated for service.

7. Provide nameplate with instructions for switching from drive to bypass and from bypass to drive. Provide instructions for isolating VFD for maintenance.

F. Shielded VFD Motor Cable:

1. When required:

a. Per VFD schedule.

b. Required by other portions of this specification.

c. Recommended by the manufacturer.

2. Multi-conductor single overall jacket cable, AC motor application controlled by PWM pulse-width modulation VFD applications, minimum 2000 volt rated, copper phase conductor(s) to match motor application and ratings, three copper conductor ground in direct contact with shield, copper tape or braided shield, provide with wire termination kits at VFD and motor, install per manufacturer recommendations.

3. Conduit Raceway: Contractor to size raceway per code and cable cross sectional area provided by manufacturer.

4. Installation: Contractor shall install without cable splices between VFD and motor unless approved by engineer prior to installation.

G. Forced Cooling / Heating Cabinet Enclosure:

1. When required:

a. Per VFD schedule.

b. When VFD is located exterior to the building or specified with a NEMA 3R, 4, 4X, or 12 enclosure.

2. Provide custom VFD enclosure with DX based cooling system, strip heaters, and thermostat temp controller.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. Refer to startup and commissioning requirements.

B. The VFD and all associated controller components shall be covered by a supplier parts warranty of 2 years from the time of installation. There shall be an option to extend the warranty to 5 years if initial installation is carried out by a supplier-approved contractor.

3.02 INSTALLATION

A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.

B. Install harmonic filter components in accordance with manufacturer’s instructions. Locate filters above or below VFD to minimize use of available horizontal wall space pending field conditions.

C. Adjust VFD settings per recommendations of the harmonic filter manufacturer's instructions; example: switching frequency.

D. VFD Output Feeder and Raceway: The contractor shall provide VFD shielded cable for the VFD output feeder when the distance to the motor exceeds manufacturer recommendations or the requirements of this specifications. Contractor to size raceway per code and cable cross sectional area provided by manufacturer.

E. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.

F. Provide engraved phenolic nameplates under the provisions of Section 26 0553.

G. Connections: All conduit connections to the VFD shall be by flexible conduit.

H. Input, output, and control wiring shall each be run in separate conduits.

I. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.

J. Forced Cooling / Heating Cabinet Enclosure: Coordinate installation with field conditions and manufacturer instructions. Provide additional branch circuit(s) for cooling and heating system per manufacturer requirements.

3.03 STARTUP AND COMMISSIONING

A. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.

B. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.

C. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.

D. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.

E. Document settings in the Operations and Maintenance manual.

END OF SECTION

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SECTION 26 3213
PACKAGED ENGINE GENERATOR SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Packaged engine generator system
B. Heat exchanger
C. Exhaust silencer and fittings
D. Fuel fittings and day tank
E. Fuel polishing system
F. Remote annunciator panel
G. Battery and charger
H. Weatherproof enclosure

1.02 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 22 3000 - Plumbing Equipment
B. Section 23 2100 - Hydronic Piping
C. Section 23 5700 - Heat Exchangers

1.03 REFERENCES

A. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
B. ANSI/NEMA AB 1 - Molded Case Circuit Breakers
C. ANSI/NEMA MG 1 - Motors and Generators
D. NFPA 37 - Installation and Use of Stationary Combustion Engines and Gas Turbines
E. NFPA 70 - National Electrical Code (NEC)
F. NFPA 110 - Standard for Emergency and Standby Power Systems
G. Environmental Protection Agency EPA Emission Standards for Compressed Ignition Engines
H. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at property boundaries due to sound emitted by the generator set, its components and the operation thereof.

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.
B. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
C. Submit product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.
D. Submit certification for EPA Emissions Standards for Compressed Ignition Engines.
E. Submit manufacturer's installation instructions under provisions of Section 26 0500.

1.05 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Section 26 0500.
B. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal toolbox.

C. Provide two additional sets of each fuel, oil, and air filter element required for the engine generator system. Provide additional fuel polishing filters for one year of operation.

D. Provide one fuse for every type and rating used.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 0500.

B. Store and protect products under provisions of Section 26 0500.

C. Accept packaged engine generator set and accessories on site in crates and verify damage.

D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.07 SYSTEM DESCRIPTION

A. Engine generator system to provide source of emergency and standby power.

B. System Capacity: 500 KW, 625 KVA at an elevation of 1,000 feet above sea level, and ambient temperature between -20°F and 110°F; standby rating using engine-mounted radiator.

C. Emergency Power Supply System (EPSS) shall be NFPA 110 Type 10 Class 6 Level 1.

D. Operation: In accordance with ANSI/NFPA 99.

1.08 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 26 0500 for required generator electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings. Show generator, fuel system components, battery system components, and exhaust system in 1/4" scale plan of room.

1.09 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 26 0500.

B. Accurately record location of engine generator and mechanical and electrical connections.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in packaged engine generator system.

B. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 50 miles of the project site.

1.12 WARRANTY

A. Provide a two (2) year warranty under provisions of Section 26 0500.

1.13 MAINTENANCE SERVICE

A. Furnish service and maintenance of packaged engine generator system for one (1) year from Date of Substantial Completion. Maintenance service shall be performed by skilled employees of manufacturer's designated service organization. Include quarterly exercising, and routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts, supplies, and labor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Caterpillar.

B. Cummins Power Generation.

C. Kohler.

D. MTU On Site Energy.

E. GE Waukesha.

2.02 PACKAGED ENGINE-GENERATOR SET (GEN-500)

A. Packaged engine-generator set shall be a coordinated assembly of compatible components. Stationary generators shall be listed.

B. Safety Standard: Comply with ASME B15.1 and UL 2200.

C. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, model and serial number, and component rating in integrated set and as required by the contract documents.

D. Fabricate engine-generator set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.

E. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the generator-set center of gravity.

2.03 ENGINE

A. Type: Water-cooled in-line or V-type, compression internal combustion engine.

B. Rating: Sufficient to operate at 100 percent load for two hours at specified elevation and ambient limits.

C. Fuel: Appropriate for use of No. 2 fuel oil.

D. Engine Speed: 1800 RPM.

E. Governor: Isochronous type with speed sensing.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

G. Frequency Response:

1. Steady State Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
2. Transient Response: Less than 5 percent for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady state operating band within 5 seconds.

H. Fuel System: Engine mounted diesel fuel pump and relief-bypass valve.

I. Fuel Supply System:

1. Base-Mounted Fuel Tank: UL 2085 listed fuel tank with 12 hour rated (NFPA 110 minimum run time by class) capacity. Integral rupture basin with leak detection. Provide fueling port with an overfill prevention type receptacle and lockable cap for exterior units. The tank shall include structural steel supports for top mounted engine generator set. Furnish complete with flexible fuel line connectors lockable cover, and analog level gauge. Furnish complete with float switches to indicate low 5% 25% 50% and 75% fuel level. The footprint of the base-mounted fuel tank shall not exceed the footprint of the generator frame for interior applications or the footprint of the enclosure for exterior installations.
2. Fuel Cooler: Provide unit-mounted fuel cooler with all required hoses, fittings and mounting hardware. Generators without a unit-mounted radiator shall have an integral fan powered by a 120V circuit.

J. Fuel Polishing System:

1. Fuel polishing system capable of removing 99% of emulsified water and particulate down to 3 microns from the fuel. The system shall be sized so the stored fuel capacity shall be polished at least once per week. The system shall include a pump to circulate the fuel from the storage tank through the filter/separator and return it to the tank, A gauge or alarm shall provide notification when a filter is due for change. A timer shall be set to run the pump during off peak hours.

K. Lubrication System: Engine or skid mounted filter and strainer, thermostatic control valve capable of full flow and designed to be fail safe, and crankcase drain arranged for gravity drainage with siphon or pump.

L. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F, and suitable for operation on 277 volts AC. The minimum wattage of the heater shall be watts or as recommended by the manufacturer.

M. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator set mounting frame and integral engine-driven coolant pump.

1. Fan and Core: Nonferrous-metal construction sized to contain expansion of total system. Blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator Airflow Restriction: 0.5 inches of water, maximum.
2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosive additives.
3. Provide expansion tank with gage glass and petcock, and self-contained, thermostatic-control temperature control valve.

N. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel. Provide the following accessories:

1. Battery: Voltage to match starter with capacity for three cranking cycles without recharge. Provide with battery cables and acid resistant battery tray.
2. Battery-Charging Alternator: Factory mounted on engine with solid state voltage regulation.
3. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.
4. BC-# Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
5. Provide two battery strings, two DC power supply/chargers with monitoring, and a best battery selector system. Each shall be sized to provide total starting capacity.
6. DC Power Supply/Charger: Utility grade current limiting type with battery temperature compensation designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave filtered rectifier, digital DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.
7. Best battery selector system for dual battery single load configuration. Solid-state design must isolate battery strings from each other.

O. Exhaust System: Industrial type silencer (20 to 75 Hz frequency range; 87 dBA max at 25 feet), side inlet with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. Silencer shall include a threaded opening for connection of ¾" drain line. Opening shall be flush on inside of silencer.

P. The packaged engine generator shall be certified with the current Environmental Protection Agency EPA Emissions standards.

Q. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine-generator control panel.

R. Mounting: Provide unit with suitable spring-type vibration isolators.

2.04 GENERATOR

A. Generator: ANSI/NEMA MG 1; three phase, re-connectible brushless synchronous generator with brushless exciter and PMG alternator excitation.

B. Rating: As indicated on the drawings, at 0.8 power factor, 60 Hertz at RPM to match engine rating.

C. Insulation: ANSI/NEMA MG 1, Class F.

D. Temperature Rise: 105°C continuous.

E. Enclosure: ANSI/NEMA MG 1; open drip-proof.

F. Voltage Regulation:

1. The maximum instantaneous voltage dip (IVD) shall be 28 percent.
2. Include solid-state type voltage regulator, separate from exciter to match engine and generator characteristics, with voltage regulation ±1 percent from no load to full load. Include manual controls to adjust voltage drop ±5 percent voltage level, and voltage gain.

G. Subtransient Reactance (X'd): Maximum 15 percent.

H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.05 CONTROLS AND INDICATION

A. Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator set vibration.

B. Ground Fault: Provide ground fault sensing at the generator. The sensor shall be located ahead of the generator service disconnect. Provide a ground fault indication on the engine-generator control panel. Provide an instruction nameplate at the control panel.

1. Instruction nameplate: Provide operational instructions for a ground fault indication as approved by the local Authority Having Jurisdiction.

C. GCP-#; Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:

1. Alarm indication as required by NFPA 110 for a Level 1 system.
2. AC frequency meter.
3. AC output voltmeter with phase selector switch.
4. AC output ammeter with phase selector switch.
5. Output voltage adjustment.
6. DC voltmeter (alternator battery charging).
7. Engine start/stop selector switch.
8. Engine running time meter.
9. Oil pressure gauge.
10. Engine coolant temperature gauge.
11. Shut down devices for overspeed, coolant high-temperature, coolant low-level, and oil low-pressure.
12. Fuel derangement alarm.
13. Generator overload.
14. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
15. Remote Alarm Contacts: Pre-wire SPST contacts to terminal strip for remote alarm functions required by ANSI/NFPA 99.
16. Ground fault indication.
17. Generator control and start signal failure.
18. 80% load alarm.
19. 85% load Alarm

20. 90% load alarm
21. 95% load alarm
22. Key switch, three-position selection switch.

D. Remote Engine Manual Start Control: Two-wire remote start control from fire command center. Provide all interconnecting wiring in conduit per manufacturer's requirements (by the Electrical Contractor).

E. Building Automation System Integration:

1. Provide a terminal block to allow the Facility Monitoring and Control System (FMCS) to report generator alarms. Provide individual terminal points for each of the annunciator alarms and pre-alarms. Provide an additional terminal point to combine all generator alarms under a single terminal point. Provide a permanent label for each terminal point. Each terminal will provide a binary output for the FMCS to read. Refer to Section 23 0900 for alarms reported by the FMCS.

2.06 ACCESSORIES

A. Generator Circuit Breaker: Molded or insulated case, service-rated thermal-magnetic type; 100% rated breaker complying with NEMA AB1 and UL 489. The disconnect shall simultaneously open all associated ungrounded conductors and be lockable in the open position.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator is shut down by other protective devices.
4. Mounting: Provide freestanding enclosure or mount integrally with control and monitoring panel.
5. The disconnecting means shall also shut down the prime mover, disable all start control circuits, and be configured with a mechanical reset.

B. EPO; Remote Manual Stop Station (Emergency Power Off EPO): Provide a remote manual stop station with weather proof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable cover/lens to access mushroom button, 120-volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator annunciator panel.

C. Remote Fuel Fill Station (RFFS-#): Provide a remote fuel fill station including a fill port within a surface-mounted, lockable, NEMA 3R stainless steel construction with gasketed hinged door and lockable handle. The fill port shall have a minimum overflow holding capacity of five (5) gallons. The fill port inside the cabinet shall be field coordinated. Provide dust cover for fill connection. Include local light and horn alarm with test switch and silence feature when tank level is above 95 percent full. Provide additional float switch in tank for level indication. Include the following accessories:

1. Solenoid valve to prevent additional fuel delivery to the tank when full; 120-volt power provided by Contractor.
2. Lockable drain valve for overflow.
3. Local analog gauge of main tank fuel level.
4. Local digital gauge of main tank fuel level.

D. Dual Source Fuel Filter:

1. High volume, selectable dual path, minimum two high-capacity filters, with water separation, and remote monitor / alarm.
2. Operation Functionality: Selectable path, primary and standby filter. Ability to switch between filters, replace filters, and bleed filters during generator operation.
3. Remote monitor / alarm feature wired to generator control and annunciator panel.

E. Provide dual redundant engine starters. The redundant engine starters shall be configured to start the engine when the primary engine starter fails.

2.07 OUTDOOR GENERATOR-SET ENCLOSURE SKIN-TIGHT

A. Prefabricated or pre-engineered skintight enclosure with the following features:

1. Construction: Reinforced galvanized steel, metal clad, integral structural steel framed housing anchored to a concrete foundation. Panelized aluminum housing with integral structural framing anchored to a concrete foundation. Construction shall allow access to control panels and service points. The panels shall enclose all components, including intake/exhaust louvers and sound attenuators. Extend the enclosure base frame as required for panels.
2. The generator control panel shall be located no greater than 5'-0" above finished grade for ease of access.
3. Structural Design and Anchorage: Wind resistant up to 100 mph.
4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents. Motor operators shall be spring open, power close operating at 24 volts DC. The louvers shall be connected to the generator starting batteries through appropriate control relays. Louvers shall not extend outside main generator enclosure.
5. Hinged Doors: Provide a minimum of four doors with padlocking provisions. Single doors shall be 36" wide and 84" high. Double doors shall be 60" wide and 84" high. As standard, doors shall include rain-rail moldings above all door openings, recessed, keyed mortise locks, panic bar door hardware and full weather-stripping. Doors shall be removable.
6. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits as required by engine-generator-set components.
7. Fuel Tank Vent: Provide vent piping from the fuel tank to the exterior of the enclosure.
8. Fuel Fill: Provide fill access on the exterior of the enclosure at an elevation not to exceed 5'-0" above finished grade.
9. The exhaust system silencer shall be installed within the enclosure housing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work and field dimensions are as shown on the drawings.

B. Verify that required utilities are available in proper location and ready for use.

C. Beginning of installation means installer accepts existing conditions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install remote manual stop station in location shown on plans. Provide 120 Volt power and wiring in conduit as required. Coordinate installation with the manufacturer approved shop drawings and wiring diagrams. The remote manual stop station shall shunt trip the generator mounted circuit breaker and signal the engine prime mover to stop.

C. The A-B-C phase rotation of the generator source shall match the A-B-C phase rotation of the utility source. The Contractor shall verify the generator and utility phase rotation match to prevent three phase motors and similar loads from operating backwards while being served by the generator.

3.03 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 0500 and in compliance with NFPA 110 requirements.

B. Provide portable test bank for full load test, if required. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.

C. Fill fuel tank prior to start of test.

D. The on-site installation test shall be conducted as follows:

1. With the prime mover in a "cold start" condition and the emergency load at standard operating level, a primary power failure shall be initiated by opening all switches or breakers supplying the primary power to the building or facility.
2. The test load shall be that load that is served by the Emergency Power Supply System (EPSS).
3. The time delay on start shall be observed and recorded.
4. The cranking time until the prime mover starts and runs shall be observed and recorded.
5. The time taken to reach operating speed shall be observed and recorded.
6. The voltage and frequency overshoot shall be recorded.
7. The time delay on transfer to emergency power for each switch shall be recorded. Life safety and critical branch transfer switches must transfer within 10 seconds.
8. The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.
9. The voltage, frequency, and amperes shall be recorded.
10. The prime mover oil pressure and water temperature shall be recorded, where applicable.
11. The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter.
12. When primary power is returned to the building or facility, the time delay on retransfer to primary for each switch with a minimum setting of 5 minutes shall be recorded.
13. The time delay on the prime mover cool down period and shutdown shall be recorded.
14. Allow prime mover to cool for 5 minutes.
15. A load shall be applied for 4 hours total. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate rating of the Emergency Power Supply (EPS), less applicable derating factors for site conditions. Observe and record load changes and the resultant effect on voltage and frequency.
16. The full load test shall be initiated immediately after the cooling time has expired by any method that starts the prime mover and, immediately upon reaching rated rpm, picks up 100 percent of the nameplate kW rating on one step, less applicable derating factors for site conditions.
17. During test, record the following at 5-minute intervals for the first 15 minutes and every 15 minutes for the rest of the test:
    a. Kilowatts
    b. Amperes
    c. Voltage
    d. Frequency
    e. Coolant temperature
    f. Enclosure temperature (interior)
    g. Oil pressure
    h. Engine exhaust temperature
    i. Engine inlet temperature
    j. Oil Temperature
    k. Battery charge rate

18. Upon completion of the test and after a cool down period, the crank/rest cycle shall be tested.
    a. Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.
    b. The control switch shall be set at "run" to cause the prime mover to crank.
    c. The complete crank/rest cycle shall be observed and recorded.
19. Test alarm and shutdown circuits by simulating conditions.

E. Contractor shall fill fuel tanks upon completion of test.

F. Testing documentation shall be submitted to the Architect/Engineer for review and approval.

G. Generator testing worksheets are included with this specification section.

3.04 MANUFACTURER'S FIELD SERVICES

A. Prepare, start, test, and adjust systems under provisions of Section 26 0500.

B. Provide UL field inspection of generator.

3.05 ADJUSTING

A. Adjust generator output voltage and engine speed.

3.06 CLEANING

A. Clean work under provisions of Section 26 0500.

B. Clean engine and generator surfaces. Replace oil and fuel filters.

3.07 DEMONSTRATION

A. Provide systems demonstration. Coordinate the demonstration schedule with the Owner and Architect/Engineer.

B. Describe loads connected to emergency and standby systems and restrictions for future load additions.

C. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

END OF SECTION

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SECTION 26 3600
TRANSFER SWITCH

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Automatic transfer switch with delayed transition ATS-#

B. Portable generator connection cabinet (GCC-#)

1.02 RELATED SECTIONS AND WORK

A. Refer to the Transfer Switch Schedule for rating and configuration.

1.03 QUALITY ASSURANCE

A. Manufacturer: Company specializing in automatic transfer equipment.

1.04 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control and Systems

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

D. NEMA ICS 10 - Guide to Application of Low-Voltage Automatic Transfer Switch Equipment

E. UL 1008 - Standard for Automatic Transfer Switches

F. NFPA 110 - Standard for Emergency and Standby Power Systems

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Submit product data for transfer switches showing overall dimensions, electrical connections, electrical ratings, and environmental requirements.

C. Submit manufacturer's installation instructions under provisions of Section 26 0500.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 0500.

B. Include instructions for operating equipment.

C. Include instructions for operating equipment under emergency conditions when engine generator is running.

D. Identify operating limits which may result in hazardous or unsafe conditions.

E. Document ratings of equipment and each major component.

F. Include routine preventive maintenance and lubrication schedule.

G. List special tools, maintenance materials, and replacement parts.

1.07 REGULATORY REQUIREMENTS

A. Conform to applicable code for emergency and standby electrical systems.

PART 2 - PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH WITH DELAYED TRANSITION

A. Automatic transfer switch, microprocessor controlled, three-position switch mechanism, delayed transition and load shed capable, with local manual operation.

B. Acceptable Manufacturers, Standard Grade:

1. Schneider Electric ASCO 300 Series
2. Siemens Russelectric RMT Series
3. ABB Zenith ZTG Series
4. Caterpillar CTG Series

5. Cummins OTPC Series
6. Generac W Series
7. Kohler KCS Series

C. Description: NEMA ICS 2; automatic transfer switch.

D. Configuration: Electrically-operated, three-position delayed transition / off capable, mechanically-held transfer switch.

E. Control panel shall be micro-processor based.

2.02 PORTABLE GENERATOR (GCC-#

A. Acceptable Manufacturers:

1. Foxfab FFCC Series
2. Berthold Electric Co
3. Power Temp Systems Inc
4. ESL Power Systems Triple Switch Series
5. Trystar

B. Pad mount, powder coat painted NEMA 3R housing with lockable door, 800 amps, 600 volt. Color-coded cam-lock connectors. Submit product data and dimensioned drawings. Color selection by Architect.

1. Cam Lock Configuration: Power flow from female to male; note ground / neutral configurations are opposite of phase conductors at the same connection location.

C. Kirk Key Interlock: Provide a kirk key interlock between the permeant generator and the temporary generator disconnect.

D. Three-way Manual Transfer Switch: Provide-three-way switch to allow flexible connection between; onsite generator and load bank, portable generator and load, onsite generator and load.

2.03 SERVICE CONDITIONS

A. Service Conditions: NEMA ICS 1. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

2.04 RATINGS

A. Refer to the electrical diagrams for the Withstand and Close Ratings WCR available interrupting capacity (AIC) at the transfer switch. The transfer switch shall be series rated with the equipment feeding the transfer switch. The series rating shall be the larger of the two Short Circuit Current Ratings SCCR values when the SCCR rating of the equipment feeding the normal and emergency sides of the transfer switch is not equal.

B. Series rating with upstream devices shall be allowed per UL-1008.

2.05 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.

E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

2.06 ENCLOSURE

A. Enclosure: NEMA ICS 6; Type 1.

2.07 ACCESSORIES

A. Load Shed:

1. The controller shall be capable of being programmed to automatically shed the connected load from the generator in the event of a user configurable under- frequency, under-voltage or overload condition. Under-frequency shedding shall occur if generator is less than 58Hz for greater than 3 seconds or less than 50 Hz for greater than 0.5 seconds.
2. Switch shall be configurable to pick up an output status relay upon activation of the auto load shed feature. Output shall be usable to trip/isolate downstream loads in the event of an overload.
3. Reset of the auto load shed function shall be via operator reset on display, remote reset contact input, or via network signal.

B. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.

C. Test Switch: Key operated or password protected switch. Mount in cover of enclosure to simulate failure of normal source.

D. Engine Start Signal: Rated 10 amps at 30VDC shall be provided to start the engine generator in the event of a normal source outage.

E. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.

F. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

G. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed indicating switch to normal source or emergency source.

H. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value, values shall be field adjustable.

I. Alternate Source Monitor: Monitor each line of alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent Hertz from rated nominal voltage, values shall be field adjustable.

J. Engine Exerciser: Start engine every 28 days. Run for 30 minutes before shutting down. Each event shall be configurable for Test with Load or Test Without Load. Bypass exerciser control if normal source fails during exercising period.

K. In-Phase Monitor: Inhibit transfer until source and load are within 30 electrical degrees.

L. Provide 2 N.O. and 2 N.C. isolated contacts to indicate:

1. Normal source available.
2. Emergency source available.
3. Exercise mode in operation.

M. Serial Communication Port: Two twisted pairs of shielded communication cable in conduit shall daisy chain all transfer switches with a remote annunciator.

N. Annunciators shall be located where shown on the drawings, as directed by the Owner. Extend conduit and wire as required by the manufacturer.

O. An adjustable emergency to normal pre-signal signal to elevator controller.

P. Metering Capabilities: The following metered readings shall be available at the local display.

1. Current, per phase RMS and neutral
2. Current unbalance %
3. Voltage, phase-to-phase and phase-to-neutral
4. Voltage unbalance %

5. Real power (KW), per phase and 3-phase total
6. Apparent power (KVA), per phase and 3-phase total
7. Reactive power (KVAR), per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency
10. Accumulated energy, (KWH, KVAH, and KVARH)
11. Demand, (KWH, KVA)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as instructed by the manufacturer.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means acceptance of existing conditions.

3.02 CONTROL AND SIGNAL CABLING

A. Provide control and signal cabling per manufacturer recommendations for the following systems components:

1. Remote annunciator.
2. Generator start signal. The generator start signal cabling for the following transfer switches shall be fire protected for a minimum of 2 hours using an approved method:
    a. Life safety, equipment branch transfer switches
    b. Approved Methods:
        1) Raceway or cable encased in a minimum of 2 inches of concrete cover.
        2) Listed fire resistive raceway / cable system.
        3) Raceway / cable is protected by a listed electrical circuit protective system.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 26 4100
LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Air terminals and interconnecting conductors

B. Grounding and bonding for lightning protection

1.02 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 26 0526 - Grounding and Bonding

B. Section 26 4300 - Surge Protection Devices

1.03 REFERENCES

A. ANSI/NFPA 780 - Lightning Protection Code

B. ANSI/UL 96 - Lightning Protection Components

C. LPI-175 - Lightning Protection Institute Installation Standard

D. LPI-176 - Lightning Protection Institute System Material and Components Standards

E. UL 96A - Installation Requirements for Lightning Protection Systems

1.04 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500.

B. Shop drawings shall indicate layout of air terminals, grounding electrodes, and bonding connections to structure, ground grid, and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details. Include indications for use of raceway and type, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

C. Product data shall show dimensions and materials of each component, and include indication of listing in accordance with ANSI/UL 96 or a nationally recognized testing laboratory.

D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.

E. Submit manufacturer's installation instructions under provisions of Section 26 0500.

F. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the single-ply membrane roofing material.

G. Field inspection reports indicating compliance with specified requirements.

1.05 SYSTEM DESCRIPTION

A. Lightning Protection System: System protecting the new Kitchen and Laundry building addition, consisting of air terminals on roofs, roof-mounted mechanical equipment, and penthouse roofs; bonding of structure and other metal objects; grounding electrodes; and interconnecting conductors. Class I materials shall be used for systems on structures not exceeding 75 feet in height. Class II materials shall be used for systems on structures exceeding 75 feet in height above grade.

B. Performance Statement: This specification and the accompanying roof plans describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every air terminal, conductor, and connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all equipment and wiring required for a complete and operational system.

1.06 PROJECT RECORD DOCUMENTS

A. Submit project record documents under provisions of Section 26 0500.

B. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

C. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.07 QUALIFICATIONS

A. Manufacturer: Company specializing in lightning protection equipment and a member of the Lightning Protection Institute or who is listed by a nationally recognized testing laboratory.

B. Installer: Authorized installer of manufacturer and certified by the Lightning Protection Institute.

C. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

1.08 PRE-INSTALLATION CONFERENCE

A. Convene a pre-installation conference one week prior to commencing work of this Section.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work under provisions of Section 26 0500.

B. Coordinate the work of this Section with exterior and interior finish installations. Coordinate painting of exposed conduits to match building finish with Architect.

C. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

D. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Heary Brothers Lightning Protection Co., Inc

B. Thompson Lightning Protection

C. Harger Lightning Protection

D. Robbins Lightning, Inc

E. Erico International Corporation

F. Burndy Thermoweld

G. VFC Lightning Protection

2.02 MATERIALS

A. All materials shall be copper and/or copper-bronze. In locations where the system components are mounted on aluminum surfaces, aluminum materials shall be used to avoid electrolytic corrosion of dissimilar metals.

B. Components: In accordance with ANSI/UL 96 or nationally recognized testing laboratory.

C. Air Terminals: Solid, unless otherwise indicated. Provide air terminals with safety 3/4" sphere tip. Provide swivel adapters to plumb air terminals when mounting on sloping surfaces.

D. Air Terminal for Chimney: Lead-coated copper.

E. Grounding Rods: Copper clad steel.

F. Ground Plate: 18"x18"x0.032" Copper ground plate.

G. Connectors and Splicers: Bronze, unless otherwise indicated.

H. Early Stream Emitter (ESE) Air Terminal: Enhanced air terminal.

I. ESE Mast: Aluminum or stainless steel mast with base and supports designed for 100 mph wind and 1.3 gust factor.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that field measurements are as shown on the shop drawings.

C. Beginning of installation means installer accepts existing conditions.

3.02 PROTECTION OF SURROUNDING ELEMENTS

A. Protect elements surrounding work of this Section from damage or disfiguration.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with ANSI/NFPA 780, UL 96A, and LPI-175.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.

D. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view from exterior locations at grade within 200 feet of building.
5. Notify Architect/Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

E. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

F. Bond extremities of metal bodies exceeding 60 feet in vertical length to structural steel members.

G. Provide a ground ring electrode that meets or exceeds minimum requirements in NFPA 780.

1. Bond ground terminals to ground ring electrode.
2. Bond grounded metal bodies on building within 12 feet of ground to ground ring electrode.
3. Bond grounded metal bodies on building within 12 feet of roof to interconnecting loop at eave level or above.

H. Structures exceeding 60 feet in height: Bond lightning protection components with intermediate-level interconnection loop conductors to down conductors and other grounded media at maximum 60-foot intervals.

3.04 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

C. Bi-metal transition fittings shall be used when changing between aluminum and copper conductors.

3.05 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 0500.

B. Obtain the services of Underwriters' Laboratories, Inc. to provide inspection and certification of the lightning protection system under provisions of UL 96A to obtain a UL Master Label for system.

C. Install UL Master Label and attach to building at location directed by the Owner.

D. Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

END OF SECTION

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SECTION 26 4300
SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes materials and installation requirements for factory and field wired low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated distribution panels.

1.02 QUALITY ASSURANCE

A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.

B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment.

1.03 REFERENCES

A. ANSI/IEEE C62.33 - IEEE Guide on Testing of MOV components

B. ANSI/IEEE C62.35 - IEEE Guide on Testing of SAD components

C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits

D. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits

E. ANSI/UL 1449 Latest Edition - UL Standard for Safety for Surge Protective Devices

F. CBEMA - Computer Business Equipment Manufacturers Association

G. IEC 664 - International Engineering Consortium, Standard for Clamping Voltage

H. NFPA 70 - National Electrical Code (NEC)

I. UL 67 - Listed for Internal Panelboard Transient Voltage Surge Suppressors

J. UL 96A - Devices listed as approved for secondary surge arrestors (VZCA)

K. UL 248-1 - Fusing

L. UL 1283 - Electromagnetic Interference Filters, Fifth Edition

1.04 SUBMITTALS

A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.

B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

1.05 SPARE PARTS

A. Surge Protection Modules: Furnish 1 replacement module for each type installed.

B. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

1.06 TESTING, WARRANTY AND LIFE EXPECTANCY

A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.

1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.
2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).
3. A single 8 x 20µs waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.

B. Minimum Repetitive Surge Current Capacity:

1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
2. Minimum Repetitive Surge Current Capacity Test:
   a. An initial UL 1449 surge defined as 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
   b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50µs 10kV or 20kV open circuit voltage waveform and an 8 x 20µs 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
   c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.
4. Proof of such testing shall be the test log generated by the surge generator.

C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.

D. Warranty: Ten (10) years. Includes workmanship, installation and programming.

E. No scheduled parts replacement or preventative maintenance shall be required.

PART 2 - PRODUCTS

2.01 DESCRIPTION

A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems.

B. Short Circuit Current Rating: Provide factory label for SCCR rating. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

2.02 RATINGS

A. SPD-1 Secondary Distribution Suppressors:

1. For 277/480-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
   a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
   b. Nominal Discharge Current (IN): 20 kA.
   c. Mounting: Refer to the drawings.

d. Voltage Protection Rating: Refer to requirements below.

e. Components: Minimum component size of 20mm metal thermally protected oxide varistors (MOV).

2. Manufacturers:

a. Square D Surgelogic EMA Series

b. Siemens TPS3 Series

c. Eaton SPD Series

d. Current Technology Current Guard Plus

e. ASCO Power Technologies 400 Series

f. LEA International CFS Series

B. SPD-2 Secondary Distribution Suppressors:

1. For 120/208-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.

a. Surge current capacity: 100,000/200,000 amps per protection mode/phase

b. Nominal Discharge Current (IN): 20 kA.

c. Mounting: Refer to the drawings.

d. Voltage Protection Rating: Refer to requirements below.

e. Components: Minimum component size of 20mm metal thermally protected oxide varistors (MOV).

2. Manufacturers:

a. Square D Surgelogic EMA Series

b. Siemens TPS3 Series

c. Eaton SPD Series

d. Current Technology Current Guard Plus

e. ASCO Power Technologies 400 Series

f. LEA International CFS Series

C. Voltage Protection Rating:

1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).

a. 277/480 Volt, 3 phase, 4 wire.1200 Volt L-N, L-G, N-G and 1800 Volt L-L

b. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L

D. EMI/RFI Noise Rejection or Filtering:

1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.

E. Indication:

1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.

2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.

3. Provide each secondary distribution type unit(s) with a transient counter.

4. Each unit shall contain form "C" contacts for remote indication of an alarm status.

F. Fuses:

1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.

2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.

B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

3.02 INSTALLATION

A. Mounting Location:

1. The unit shall be installed as close as practical to the panel secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the panel using a conduit nipple. Flush mount the unit in the front of the switchboard. Mount unit directly across from the breaker or disconnect serving it.

B. Connections:

1. Conductors from the protected bus to the unit shall not be any longer than necessary avoiding unnecessary bends. The conductor leads shall be twisted together and as short as possible. Connection shall be with mechanical lugs for each phase, neutral, and ground if applicable. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard. Single phase 120-volt units shall be hardwired without a disconnecting means.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

C. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

END OF SECTION

SECTION 26 5119
LED LIGHTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires and accessories

B. Exterior luminaires and accessories

C. Light-emitting diode (LED) luminaire systems

D. LED emergency lighting units

E. Emergency exit signs

F. Lighting poles

1.02 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 09 33 Lighting Control Systems
2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details.

1.03 REFERENCES

A. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products

B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement

C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment

D. NFPA 70E - National Electrical Safety Code

E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System

F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products

G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED

I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)

J. UL 924 - Standard for Emergency Lighting and Power Equipment

1.04 SUBMITTALS

A. Submit product data under provisions of Section 26 0500.

B. Basic Requirements of Submittal:

1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's, LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
3. Include outline drawings, support points, weights, and accessory information for each luminaire.
4. Submit manufacturer origin of LED chipset and driver.

C. LED Lighting - Performance Testing Submittal (when requested by Architect/Engineer):

1. IESNA LM-79: Include photometric report for the latest generation system being furnished. Provide name of independent testing laboratory, report number, date of test, luminaire series/model number, input wattage, and light source specifications.
2. IESNA LM-80: Measuring Lumen Maintenance of LED Light Sources.

D. LED Lighting - Control Compatibility Submittal:

1. Submit lighting control capability data for each LED luminaire. The submittal shall clearly identify device data proposed by the Contractor and approved by the luminaire manufacturer for dimming, switching, addressable, wireless, and similar control characteristics.

E. Submit Design Lights Consortium (DLC) information for each luminaire type.

F. Submit utility rebate forms where offered at project location. Submit completed rebate forms within 30 days of Substantial Completion.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site. Store and protect under provisions of Section 26 0500.

B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.

C. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.06 WARRANTY

A. The warranty period begins at the date of Substantial Completion.

B. LED Light Engines and Drivers:

1. LED Drivers and Dimming Drivers: Five (5) years
2. Light Emitting Diode (LED) Light Engines: Five (5) years

C. Emergency Lighting Units and Exit Signs:

1. Emergency Lighting Units: Three (3) year, non-prorated
2. Exit Signs: Three (3) year, non-prorated
3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.

D. Pole Finish: Three (3) year warranty of pole color and finish

1.07 REGULATORY REQUIREMENTS

A. Conform to NFPA 101 for installation requirements

PART 2 - PRODUCTS

2.01 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.

B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.

C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction.

D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.

E. Painted reflector surfaces shall have a minimum reflectance of 90%.

F. All painted components shall be painted after fabrication.

2.02 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.

B. Provide low temperature LED drivers, with reliable starting to -20°F.

C. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

2.03 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 80. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

B. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.

C. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.

D. Rated life shall be minimum of 50,000 hours at L70.

E. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.

F. Luminaire delivered lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.

G. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.

H. LED light engine shall have a maximum LLD of 0.85 at 50,000 hours at 25°C ambient.

I. LED Driver:

1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.
3. Driver shall have a minimum of 50,000 hours rated life.
4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
5. Driver shall be field replaceable without removal of the luminaire.
6. Class A sound rating; inaudible in a 27 dBA ambient.
7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

2.04 LED EMERGENCY LIGHTING UNITS

A. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

B. Battery: Maintenance free lead calcium type, with 90 minute capacity to supply the connected lamp load.

C. Charger: Dual-rate solid state current limiting charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 168 hours. Low voltage disconnect to prevent deep discharge of battery.

D. LED Lamp Wattage: As scheduled on luminaire schedule.

E. Remote Lamps: Match LED lamps on unit.

F. Indicators: Provide lamps to indicate AC ON and RECHARGING.

G. Provide test switch to transfer unit from normal supply to battery supply.

H. Electrical Connection: Knockout for conduit connection.

I. Unit Voltage: Refer to luminaire schedule volts, AC.

J. Self-Diagnostics and Testing:

1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.

2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five-minute discharge/diagnostic test at any time.

2.05 EMERGENCY EXIT SIGNS

A. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.

B. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.

1. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Provide independent support as follows:

a. Luminaires less than 56 lbs.: Provide a minimum of two (2) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires.

b. Luminaires 56 lbs. or greater: Provide a minimum of four (4) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires. Support luminaire independent of the ceiling system.

c. Luminaires larger than eight square feet (8 ft2): Support luminaire independent of the ceiling system.

B. Do not fasten luminaire supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted. Support wires shall be tightly wrapped (minimum of three turns within 3 inches of the connection) and sharply bend to prevent vertical movement.

C. Support suspended or pendant mounted luminaires independent of ceiling grid with adjustable stainless steel aircraft cables or per luminaire schedule mounting requirements. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.

D. Support wire used to independently support luminaires, raceways, and wiring systems shall be distinguishable from ceiling support systems by color (field paint), tagging or equivalent means.

E. Install lamps in lamp holders of luminaires.

F. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.

G. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.

H. Industrial Pendant Luminaires: Use hangers rated 500 pounds minimum or provide safety chain between driver and structure. Provide safety chain between reflector and driver.

I. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.02 CONSTRUCTION USE OF PROJECT LUMINAIRES

A. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

3.03 EMERGENCY LIGHTING UNITS AND EXIT SIGNS

A. Install units plumb and level.

B. Aim directional lamp heads as directed.

C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.04 RELAMPING

A. Replace failed LED light engine modules or arrays at completion of work.

3.05 ADJUSTING AND CLEANING

A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

B. Touch up luminaire and pole finish at completion of work.

3.06 OWNER TRAINING

A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner's Representative.

B. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.07 LUMINAIRE SCHEDULE

A. As shown on the drawings.

END OF SECTION

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SECTION 27 0500
BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Communications Systems.

B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Communications Work a finished and working system.

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Description of Systems include, but are not limited to, the following:

1. Extension of existing Structured Cabling System including, but not limited to:
    a. Voice and data backbone cabling and terminations.
    b. Voice and data horizontal cabling and terminations.
    c. Information outlets (IOs) including faceplates, jacks and labeling.
    d. Equipment racks, cabinets, cable management and equipment.
    e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
    f. Cabling pathways.
    g. Grounding and Bonding
    h. Testing
2. Extension of existing Paging Systems.
3. Mounting and patching of wireless access points provided by others.
4. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.
5. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
6. Firestopping of penetrations as described in Division 7.

1.03 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.04 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall

the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.
2. "Electrical Contractor" shall also refer to the Contractor listed in Division 27 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
3. "Technology Contractor" as referred to herein refers to the Contractors listed in Division 27 of this Specification.
4. Low Voltage Technology Wiring: The wiring (less than 120VAC) associated with the Technology Systems, used for analog and/or digital signals between equipment.
5. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications/technology outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling.

C. General:

1. The purpose of these specifications is to outline typical Electrical and Technology Contractor's work responsibilities as related to technology systems including telecommunications rough-in, conduit, power wiring, and low voltage communications and technology wiring. The prime contractor is responsible for all divisions of work.
2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the technology drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the technology drawings but required for the successful operation of the systems shall be the responsibility of the Technology Contractor and included in the Contractor's bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of technology systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.
4. This Contractor shall establish electrical and technology utility elevations prior to fabrication and installation. The Technology Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
    a. Lighting Fixtures
    b. Gravity Flow Piping, including Steam and Condensate
    c. Sheet Metal
    d. Electrical Busduct
    e. Sprinkler Piping and other Piping
    f. Conduit and Wireway
    g. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Responsible for Communications Systems grounding and bonding.

3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."
3. Assumes all responsibility for providing and installing all cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the technology bonding system.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.05 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
   a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
   b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
   c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
   d. Maintenance clearances and code-required dedicated space shall be included.
   e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
   a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
   a. Scale of drawings:
      1) General plans: 1/4 Inch = 1 '-0" (minimum).
      2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
      3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
      4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).
      5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
   a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
   b. Potential layout changes shall be made to avoid additional access panels.

c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.06 QUALITY ASSURANCE

A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:

a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling

b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises

1) C.1 - Commercial Building Telecommunications Standard

2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard

3) C.3 - Optical Fiber Cabling Components Standard

c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces

d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure

e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

f. ANSI/TIA-862-A - Building Automation Systems Cabling Standard

g. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers

h. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

i. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding

j. NFPA 70 (NEC) - National Electrical Code (Current Edition)

k. UL 444 - Standard for Safety for Communications Cable

B. Refer to individual sections for additional Quality Assurance requirements.

C. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.

2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.

3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.

4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.
6. The Contractor must have a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) on-staff serving as a project manager. Project shop drawings and test reports shall be stamped by the RCDD or CNIDP.
7. The Contractor shall obtain the services of a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) for the project. The RCDD or CNIDP shall perform the following tasks on the project:
    a. Review contractor's submittals and stamp the submittals stating the submittals compliance with the contract documents.
    b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks during the construction period.
    c. Provide a final written and dated confirmation of a final construction review prior to testing.
    d. Review final testing of system and indication that the documented results or transmittal of the results stating the test results compliance with the contract documents.
8. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
    a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.
    b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
    c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.
    d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.
    e. Resume and certification of the RCDD or CNIDP for the project as required by the form at the end of this specification section.
    f. Resume and certification of the BICSI installation technician or CNet CNIT for the project.

D. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the State of Iowa’s Codes, Laws, Ordinances and other regulations having jurisdiction.
2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.
7. Pay any charges by the service provider related to the service or change in service to the project.
8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):
    a. Factory Mutual
    b. Underwriters' Laboratories, Inc.

F. Examination of Drawings:

1. The drawings for the technology systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.
2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.
3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.07 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
27 05 26	Communications Bonding
27 05 28	Interior Communications Pathways
27 05 53	Identification and Administration
27 11 00	Communication Equipment Rooms
27 13 00	Backbone Cabling Requirements
27 15 00	Horizontal Cabling Requirements
27 17 10	Testing
27 51 13	Paging Systems

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Description of items submitted and relevant specification number
   e. Notations of deviations from the contract documents
   f. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Description of item submitted (using project nomenclature) and relevant specification number
   g. Notations of deviations from the contract documents

h. Other pertinent data

i. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor shall provide proof of RCDD or CNIDP review on the submittal.

d. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.

7) Dimensions and service clearances are suitable for the intended location.

8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.

9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

f. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements**.**

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.

a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.

16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

a. Submittal file name: 27 XX XX.description.YYYYMMDD

b. Transmittal file name: 27 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.08 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.

2. Submit in Excel format.

3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
   a. Material: Delivered cost of product with taxes paid.
   b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
   a. Overhead and profit.
   b. Bonds.
   c. Insurance.
   d. General Requirements: Itemize all requirements.
4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
   a. Structured cabling
   b. Overhead paging systems

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of Subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.09 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.10 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:

1. Firestopping, including mechanical firestop systems.

1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.13 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.

B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.14 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.01 CABLE JACKET RATING

A. This project requires all cable jackets to carry a plenum rating.

2.02 Refer to individual sections.

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 0533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.03 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 27 sections for further requirements.
2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
5. All communications cable tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other

surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.04 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
2. Submitted bound copies of approved shop drawings.
3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to the project site; submit receipt to Architect/Engineer prior to final payment being approved.
8. Provide System Assurance Warranty certificate for the telecommunications system.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
   a. O&M file name: O&M.div27.contractor.YYYYMMDD
   b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.

E. Refer to the individual specification sections for minimum hours of instruction time for each system.

F. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the Communications Systems.

2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 SYSTEM STARTING AND ADJUSTING

A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.08 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of technology drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record actual routing of all conduits sized 2" or larger.

E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.09 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All overhead or integrated paging systems, including speakers, back boxes, cabling, and power supplies, and all headend equipment is installed, programmed and operational.
9. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
10. All access control system equipment, including conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational by Owner security vendor Accurate Controls, Inc.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.

It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

TELECOMMUNICATIONS - PROOF OF CERTIFICATION

There are specific Contractor qualification requirements for this project as defined in Section 27 0500, which may include Manufacturer Certification and RCDD or CNIDP credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

Statement of Compliance:

Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the _____ day of _____, 20____.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: _____

Authorized Representative: (print) _____

Date: _____

Manufacturer Certification Number (if any): _____

If this project requires RCDD certification, complete the following:

RCDD or CNIDP Name: _____

RCDD #: _____ Expiration: _____

Submit the following with the bid:

This form.

Proof of Manufacturer Certification indicated above.

Proof of RCDD or CNIDP status.

END OF SECTION

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SECTION 27 0505
TECHNOLOGY DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Technology demolition.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements.

1.03 REFERENCES

A. NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment for terminating, patching and cross connecting of existing telecommunications and security systems shall be as specified in individual Sections.

PART 3 - EXECUTION

3.01 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY OUTLET, BOX, CONDUIT, OR CABLE THAT MUST BE REMOVED.

B. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS AND SCOPE OF WORK.

C. Whenever possible, the Contractor shall coil existing cable above ceiling for re-termination if cable length will allow. Re-terminated cables shall be tested for wire map and continuity.

D. Where walls, ceilings, structures, etc., are indicated as being renovated on general drawings, the Contractor shall be responsible for the removal of all technology equipment including but not limited to: copper, fiber and coaxial cable, faceplates and jacks, raceways, racking and equipment mounted to the racking, etc., from the renovated area.

E. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

F. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area.

G. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and technology service to avoid conflicts.

3.02 PREPARATION

A. Not all services within the building will be inactive or abandoned. Verify abandonment status with the building owner, trade contractors and Architect/Engineer prior to demolition.

B. Prior to commencing with demolition, a proposed implementation narrative with schedule shall be submitted to the Architect/Engineer for approval.

C. The contractor shall provide proof that only qualified personnel with extensive telecommunications experience will perform the demolition. No laborers will be allowed in the cable removal process.

D. The contractor shall coordinate with owner to verify all cabling, patch cords and cross connects have been removed from active equipment that is to remain during the duration of the renovation.

E. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on active equipment, use technicians experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

3.03 DEMOLITION AND EXTENSION OF EXISTING TECHNOLOGY WORK

A. Demolish and extend existing technology work under provisions of Division 1 of Architectural Specifications and this Section.

B. Some cabling within the ceiling space may serve other building tenants; care shall be exercised to prevent service interrupts.

C. Remove, relocate, and extend existing installations to accommodate new construction.

D. Remove abandoned low voltage cabling and raceway to source of cabling according to the NEC. Refer to the NEC for definition of Abandoned Communications Cabling.

E. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

F. Disconnect and remove abandoned patch panels, blocks and other distribution equipment.

G. Maintain access to existing technology installations that remain active. Modify installation or provide access panels as appropriate.

H. Extend existing installations using materials and methods compatible with existing technology installations, or as specified.

I. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

J. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.04 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Patch panels, blocks and other connectivity equipment: Clean exposed surfaces and check tightness of connections. Re-terminate any loose connections; the contractor shall notify the Architect/Engineer of any permanently damaged or unusable equipment.

C. TECHNOLOGY ITEMS (E.G., PATCH PANELS, EQUIPMENT RACKS, JACKS, FACEPLATES, BLOCKS, CABLING, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.05 INSTALLATION

A. Install relocated materials and equipment under the provisions of applicable Division 27 specifications.

END OF SECTION

SECTION 27 0526
COMMUNICATIONS BONDING

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 26 0513 - Wire and Cable

C. Section 26 0526 - Grounding and Bonding

D. Section 26 4100 - Lightning Protection Systems

E. Section 27 0500 - Basic Communications Systems Requirements

F. Section 27 1100 - Communication Equipment Rooms

G. Section 27 0528 - Interior Communication Pathways

H. Section 27 0553 - Identification and Administration

1.02 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

B. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

1.03 REFERENCES

A. ANSI/IEEE 1100 - Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems

B. ANSI/TIA/EIA 568-C - Commercial Building Telecommunications Cabling Standard

C. ANSI/TIA/EIA 569-A - Commercial Building Standard for Telecommunications Pathways and Spaces

D. ANSI-J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

E. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements

F. IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding

G. NFPA 70 - National Electrical Code

H. NFPA 780 - Standard for the Installation of Lightning Protection Systems

I. UL 96 - Lightning Protection Components

J. UL 96A - Installation Requirements for Lightning Protection Systems

K. UL 467 - Grounding and Bonding Equipment

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 0500.

B. Store and protect products under the provisions of Section 27 0500.

C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

1.05 SYSTEM DESCRIPTION

A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.

B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.

C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.

D. Basic System Requirements:

1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.
2. The bonding system shall include, but not be limited to, the following major components:
    a. Bonding Conductor for Telecommunications (BCT)
    b. Existing Telecommunications Main Grounding Busbar (TMGB)
    c. Telecommunications Bonding Backbone (TBB)
    d. Telecommunications Grounding Busbar(s) (TGB)
    e. Rack mount Telecommunications Grounding Busbar(s)
    f. Bonding Conductor(s) (BC)
    g. Bonding Connectors
    h. Bonding system labeling and administration as defined in Section 27 0553.

1.06 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 0500.

B. Provide final system block diagram showing any deviations from approved shop drawing submittal.

C. Provide floor plans that document the following:

1. Actual locations of system components, devices, and equipment.
2. Actual conductor routing.
3. Actual system component, device, equipment, and conductor labels.

D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.

E. Complete all operation and maintenance manuals as described below.

PART 2 - PRODUCTS

2.01 BONDING CONDUCTORS

A. Bare Copper:

1. Annealed uncoated stranded conductor.
2. Minimum size 6 AWG.

B. Insulated Copper:

1. Annealed uncoated stranded conductor.
2. Insulation:
    a. PVC insulation with nylon outer jacket.
    b. Rated at 600 volts.
    c. Green.

3. Minimum size 6 AWG.

C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.

D. Bonding Conductor Sizing:

1. All communications bonding system conductors shall be sized by length as follows:

Length Linear ft (m)	Size (AWG)
Less than 13 (4)	6
14 - 20 (4 - 6)	4
21 - 26 (6 - 8)	3
27 - 33 (8 - 10)	2
34 - 41 (10 - 13)	1
42 - 52 (13 - 16)	1/0
53 - 66 (16 - 20)	2/0
Greater than 66 (20)	3/0

2. The BCT shall be the same size as the TBB or larger.

2.02 BONDING CONNECTORS

A. Acceptable Types:

1. Two-hole compression lug
2. Exothermic weld
3. Irreversible compression

B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.

C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

2.03 GROUNDING BUSBAR (TMGB AND TGB)

A. Features:

1. Wall-mount configuration.
2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
4. Predrilled holes.
5. Integral insulators.
6. Stainless steel offset mounting brackets.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.
   a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
   a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.

b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

2.04 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

A. Features:

1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
2. Predrilled holes.
3. Mounts in a standard 19" equipment rack.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.
2. Minimum Dimensions: 3/16" thick x 3/4" high x 19" long.
   a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.
3. Hole pattern shall include:
   a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1" centers.
   b. A minimum of two (2) pairs of 5/16" diameter holes spaced 3/4" apart.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.
2. A licensed electrician shall perform all bonding.
3. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Telecommunications Ground Bar (TGB) Requirements:

1. Provide a TGB in each telecommunications equipment room.
2. Install TGB such that it is insulated from its support with a minimum 2" standoff.
3. Bond each TGB to the TMGB via the TBB.
   a. A minimum of 1 foot separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.
   b. The TBB may be routed from TGB to TGB or as a radial feed to each TGB as the layout requires.
4. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.
5. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.
6. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.
7. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.

C. Metallic Interior Communication Pathway Bonding Requirements:

1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, and ladder rack, shall be bonded to the communications bonding system.

D. Bonding Conductor Requirements:

1. Bonding conductors shall be green or marked with a distinctive green color.
2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.
3. Bonding conductors shall not be installed in metallic conduit.
4. All conductors, including, but not limited, to the BCT, TBB, GE(s), and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.
    a. Where documented permission to splice a conductor is granted:
        1) The number of splices shall be limited to as few as possible.
        2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.
        3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.
        4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.
5. All bonding conductors shall be labeled in accordance with the requirements of Section 27 0553. In addition to the requirements of Section 27 0553:
    a. Labels shall be nonmetallic.
    b. Labels shall be printer-generated.
    c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.
    d. Additionally, conductors shall be labeled as follows:
        1) "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER."
6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.
7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.

E. Bonding Connection Requirements:

1. Make all connections in accessible locations to facilitate future inspection and maintenance.
2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.
3. Thoroughly clean conductors before installing lugs and connectors.
4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.

5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.
6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.
7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

3.02 FIELD QUALITY CONTROL

A. Field testing shall be performed under provisions of Section 27 0500.

B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

3.03 ADJUSTING

A. Adjust work under provisions of Section 27 0500.

B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

3.04 TESTING

A. Test installed system under provisions of Section 27 1710.

B. Measure and document resistance to ground at TGB, each RTGB, and each electrical distribution panel bonded to the TGB.

1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms.
3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.

C. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 1710.

END OF SECTION

SECTION 27 0528
INTERIOR COMMUNICATION PATHWAYS

PART 1 - GENERAL

1.01 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 27 0500 - Basic Communications Systems Requirements

C. Section 27 0526 - Communications Bonding

1.02 QUALITY ASSURANCE

A. Refer to Section 27 0500 for requirements.

1.03 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.
2. Manufacturer's installation instructions.

B. Coordination Drawings:

1. Include conduit sleeve layout in composite electronic coordination files. Refer to Section 27 0500 for coordination drawing requirements.

1.05 DRAWINGS

A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Refer to Section 26 05 33 for conduit requirements for this project.

2.02 CABLE HANGERS AND SUPPORTS

A. Provide a non-continuous cable support system suitable for use with open cable.

B. Cable Hooks:

1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.
2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.
3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use.

C. Cable Hangers:

1. Adjustable, non-continuous cable support slings for use with low voltage cabling.
2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.
3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.
4. Cabling hanger load limit shall be 100 lbs. per foot.

5. Manufacturer:
    a. Erico Caddy
    b. CableCat CAT425
    c. Arlington Fittings Tl Series
    d. Or approved equal.

2.03 INNERDUCT - CORRUGATED

A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.

B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.

C. Solvent-cement type joints as recommended by manufacturer.

D. Inside diameter not less than that of rigid steel conduit.

E. Dielectric strength a minimum of 400 volts per mil.

F. Corrugated wall construction.

G. Pull rope pre-installed by manufacturer.

H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all the above General requirements plus:

1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.
2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).

I. Innerduct installed within building riser shafts shall meet all the above general requirements plus:

1. Be fabricated of flame-retardant materials suitable for installation in such environment.

J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

PART 3 - EXECUTION

3.01 INNER DUCT INSTALLATION REQUIREMENTS

A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

B. All exposed inner duct is to be labeled at 35-foot intervals with tags indicating ownership, the cable type (e.g., "Fiber Optic Cable") and the cables it contains (e.g., MA-CS or FS-CS).

C. Where exposed, fiber optic cable shall be installed in protective inner duct.

D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.

E. The inner duct should extend into the termination enclosure at system endpoints.

F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

3.02 CABLE HOOK SUPPORT SYSTEM

A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.

B. Refer to manufacturer's requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.

C. Cable hooks shall be securely mounted per manufacturer's instructions. In no case shall the side-to-side travel of any cable hook exceed 6".

D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

E. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet.

F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.

G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

3.03 CONDUIT AND CABLE ROUTING

A. Refer to Section 26 0533 for additional requirements.

B. All conduits shall be reamed and shall be installed with a nylon bushing.

C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.

D. No conduit or sleeve containing more than two (2) cables shall exceed 40% fill ratio, regardless of length.

E. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.

1. A separate pull box is required for each 90' (or greater) length section.
2. A separate pull box is required after any two (2) consecutive 90-degree bends.
3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.

F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.

G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

3.04 ATTACHMENT TO METAL DECKING

A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hangar and a minimum spacing of 2'-0" on center. This 25-lb. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

END OF SECTION

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SECTION 27 0553
IDENTIFICATION AND ADMINISTRATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the identification and administration requirements relating to the structured cabling system and its termination components and related subsystems.

B. Identification and labeling.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Documentation of labeling scheme.

PART 2 - PRODUCTS

2.01 LABELING

A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.

B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.

C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface an attachment method.

D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.

1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum "quite zone" of 0.25" on each side of the bar code.
2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.

E. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:

1. (Telecom Room Number) - (Patch Panel Letter) - (Patch Panel Port Number).
2. "Telecom Room Number" shall be as indicated on the drawings.
3. "Patch Panel Letter" shall start with 'A' for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.
4. "Patch Panel Port Number" shall start with '1' for the upper left port in each modular patch panel, increasing sequentially from left to right and top to bottom across the modular patch panel face.
5. Example #1: MC/1-A3 indicates the third modular patch panel port in modular patch panel 'A' in Main Equipment Room (MC/1).
6. Example #2: HC/2-C39 indicates the thirty-ninth modular patch panel port in modular patch panel C in Horizontal Cross-Connect room (HC/2).

2.02 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 0500 and Division 1. Documentation shall include the items detailed in the subsections below.
2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION

3.01 IDENTIFICATION AND LABELING

A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.

1. Provide additional cable labeling at each manhole and pull box.
2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.
3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.

B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.

END OF SECTION

SECTION 27 1100
COMMUNICATION EQUIPMENT ROOMS (CER)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the products and execution requirements related to furnishing and installing equipment for communication equipment rooms.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

B. Section 27 0526 - Communications Bonding

C. Section 27 0528 - Interior Communication Pathways

D. Section 27 1500 - Horizontal Cabling Requirements

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for applicable standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

PART 2 - PRODUCTS

2.01 EQUIPMENT GROUNDING

A. Refer to specification section 27 0526 for grounding requirements.

B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.02 EQUIPMENT RACKS AND CABINETS

A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.

B. The equipment rack shall conform to the following requirements:

1. Standard TIA/EIA 19" Wall Cabinet:

a. The equipment cabinets shall be constructed of painted steel or aluminum and offer a usable mounting height of 15 RU. Racks shall be a minimum of 21 inches deep. Access to the rear of the cabinet-mounted equipment shall be by a hinged arrangement.

b. The equipment cabinet shall be equipped with a lockable steel front door and furnished with two (2) keys that shall be usable on all cabinets furnished under this Contract.

c. The equipment cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting. The cabinet shall be tapped to accept 12-24 screws.

d. The equipment cabinet shall be vented to allow for airflow through the cabinet.

2.03 CABLE MANAGEMENT - HORIZONTAL

A. Equipment Cabinets

1. Equipment cabinets shall be equipped with vertical and horizontal cable management hardware, in the form of rings and guides, to allow an orderly routing of optical fiber and copper jumpers from the modular patch panels to the customer provided network electronics. At a minimum, one such horizontal cable management panel shall be provided with each equipment cabinet. Horizontal

cable management panels shall be 3.5" in height and have a minimum of five (5) jumper distribution rings.

2.04 PATCH PANELS

A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.

B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 1500.

C. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.

D. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.

E. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

2.05 OPTICAL FIBER PANELS

A. All terminated optical fibers shall be mated to simplex LC-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., "FDDI Connector"), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted.

B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.

C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.

D. Access to the inside of the fiber distribution cabinet's enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.

E. The fiber distribution cabinet's enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer's recommended minimums or ½½", whichever is larger.

F. All fiber distribution cabinets shall provide protection to both the "facilities" and "user" side of the coupling. The fiber distribution cabinet's enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet's enclosure shall provide a physical barrier to access such optical fiber cables.

G. Where "Loose Buffered" cables are installed, the 250 µµm coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtails") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar¢¢) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µµm coated optical fibers shall not be permitted.

H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.

2.06 OPTICAL FIBER COUPLERS/ADAPTERS

A. Optical Fiber Couplings (LCtype) (Multimode/Singlemode):

1. LC-type optical fiber couplings shall be used to terminate optical fiber backbone cable on fiber distribution cabinet panels in communication equipment rooms. Horizontal optical fiber cables shall also be terminated using optical fiber couplings at their designated work area locations on information outlet faceplates for "fiber to the desk."
2. LC-type optical fiber couplings shall be snap-type with locking washer and nut.
3. LC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.
4. LC-type optical fiber couplings shall accept 125-micron outside diameter multimode fiber.
5. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.
6. LC-type optical fiber couplings shall meet the following performance criteria:

Test Procedure	Maximum Attenuation Change
Cable Retention (FOTP-6)	0.2 dB
Durability (FOTP-21)	0.2 dB
Impact (FOTP-2)	0.2 dB
Thermal Shock (FOTP-3)	0.2 dB
Humidity (FOTP-5)	0.2 dB

7. Performance Requirements:
   a. Length: 2 inches
   b. Operating Temperature: -40 to 85 degrees C
8. Basis of Design:
   a. Hubbell

2.07 D-RINGS

A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.

B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.

C. Provide 1/4" screw holes for wall mounting.

2.08 POWER STRIPS

A. Provide power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:

1. Standard Rack Mount:
   a. TIA/EIA 19" equipment rack mountable.
   b. Compliant with UL-1449 Third Edition and UL-497A.
   c. Provide transient suppression to 12,000-A. Protection shall be in all three modes (line-neutral, line-ground and neutral-ground).
   d. Shall meet or exceed ANSI C62 Category A3 requirements.

e. Provide high-frequency noise suppression as follows:
   1) Greater than 20-dB @ 50 kHz
   2) Greater than 40-dB @ 150 kHz
   3) Greater than 80-dB @ 1 MHz
   4) Greater than 30-dB @ 6 to 1000 MHz
f. Protection Modes and UL 1449 Clamping Voltage: 475 volt L-N, L-G, and N-G.
g. Components: Nonmodular units composed of 20mm metal oxide varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.
h. Be equipped with a 10-foot power cord.

2.09 COPPER PATCH CORDS

A. Modular Patch Panel:
1. Provide Category 6 copper patch cords for 50% of all assigned ports on the modular patch panel. Of these cords, 60% shall be 3' in length and 40% shall be 5' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.
2. Refer to Section 27 1500 for cable and connector performance requirements.
3. Patch cords shall not be made-up in the field.

2.10 FIBER PATCH CORDS

A. Optical Fiber Patch Cords (Multimode):
1. Provide 50/125 mm multimode (MM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped LC-type connector on each end and shall be a minimum of 5 feet in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.
2. Channels shall be of equal length.
3. Refer to Section 27 1500 for cable and connector performance requirements.
4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):
   a. Hubbell DFPC Series

PART 3 - EXECUTION

3.01 D-RINGS

A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.
B. Locate D-rings on 24" centers vertically and horizontally.
C. Securely attach D-rings to the wall as required by the manufacturer.

3.02 CROSS CONNECT INSTALLATION

A. Bend radius of cable shall not exceed 4 times the outside cable diameter or manufacturer's recommendation, whichever is less.
B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.
C. The cable jacket shall be maintained as close as possible to the termination point.
D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support.

3.03 OPTICAL FIBER TERMINATION

A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.

B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.

C. Each cable shall be clearly labeled at the entrance to all enclosures.

D. A maximum of 12 strands shall be spliced in any tray.

3.04 CONDUITS AND CABLE ROUTING

A. Refer to Section 26 0533 for additional requirements.

B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3" above the floor slab.

C. All conduits shall be reamed and shall be installed with a nylon bushing.

D. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2" or less, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

END OF SECTION

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SECTION 27 1500
HORIZONTAL CABLING REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper cabling.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

B. Section 27 1720 - Structured Cabling System Warranty

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards and plenum or non-plenum cable requirements.

B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).

C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.

D. The installing contractor must be certified by the manufacturer of the structured cabling system.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

PART 2 - PRODUCTS

2.01 HORIZONTAL CABLE

A. CAT 6 Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.
2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.
3. Performance tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.
4. Performance data shall be characterized as "Guaranteed Headroom" and shall be guaranteed by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.
5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 1720 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.

6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

Electrical Value (1 - 250 MHz)	Minimum Margin
Insertion Loss:	5%
NEXT:	3.0 dB
PS NEXT:	5.0 dB
ACR-F (ELFEXT):	4.0 dB
PS ACR-F (PS ELFEXT):	5.0 dB
Return Loss:	2.0 dB

7. The jacket color for CAT 6 cable shall be white for voice applications and blue for data applications.
8. Basis of Design:
   a. Hubbell HC6R Series
   b. Additional acceptable manufacturers:
      1) Belden
      2) Berk-Tek
      3) Commscope/Uniprise
      4) Panduit
      5) Siemon
      6) Superior Essex

2.02 FACEPLATES/JACKS

A. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.
2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.
3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.
5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.
6. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:
   a. Match the receptacle color used for other utilities in the building, or
   b. When installed in surface raceway (if applicable), match the color of that raceway.
7. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:
   a. Be a low-profile assembly.
   b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.

c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.

d. Incorporate a shroud that protects the optical fiber couplings from impact damage.

8. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.

9. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.

10. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.

11. CAT 6 modular jacks shall be pinned per TIA-568B.

12. CAT 6 termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:

    a. ANSI/TIA/EIA-568-A-5

    b. ANSI/TIA/EIA-568A

    c. ISO/IEC 11801

    d. IEC 603-7

    e. FCC PART 68 SUBPART F

13. The color for CAT 6 jacks shall be white for voice applications and blue for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6 modular jack.

PART 3 - EXECUTION

3.01 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.

2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.

3. Manufacturer's minimum bend radius specifications shall be observed in all instances.

4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.

5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.

6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.

7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

B. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

1. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:
    a. Twelve (12) inches from power lines of less than 5-kVa.
    b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
    c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
    d. Thirty-nine (39) inches from transformers and motors.
2. Information outlets shown on floor plans with the subscript "W" are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12" vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

3.02 CABLE TERMINATION REQUIREMENTS

A. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.
2. If the "last" patch (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use.
3. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

END OF SECTION

SECTION 27 1710
TESTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to the start of work, the Contractor shall submit:

1. Complete information on testing procedure as described herein.
2. Test plan summary for each cable type to be tested including equipment to be used, setup, test frequencies or wavelengths, results format, etc.

PART 2 - PRODUCTS

2.01 TESTING COPPER

A. General Requirements:

1. Perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
3. Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove the wiring connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results in their native format.
7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.

8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
    a. CAT 6 Cable:
        1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.
        2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.
        3) CAT 6 horizontal cable shall be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Permanent Link", including cabling and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:
            a) Wire Map
            b) Length
            c) NEXT Loss (Pair-to-Pair)
            d) NEXT (Power Sum)
            e) ELFEXT (Pair-to-Pair)
            f) ELFEXT (Power Sum)
            g) Return Loss
            h) Attenuation
            i) Propagation Delay
            j) Delay Skew
        4) The maximum length of horizontal cable shall not exceed 295 feet, which allows 33 feet for technology equipment and modular patch cords.
        5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.
        6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test records shall verify "PASS" on each cable and display the specified parameters, comparing test values with standards based "templates" integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.
        7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

2.02 TESTING FIBER

A. General Requirements:

1. Perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.
2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.
3. Visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.
4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.
6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results.
7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.
8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.
9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
    a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.
    b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.

B. Tests Prior to Installation: The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. Supply this test data to the Architect/Engineer prior to installation.

C. Tests After Installation: Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:

1. Optical Attenuation ("Insertion Loss" Method):
    a. Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers

shall be tested at 850 ±± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ±± 20 nm.

b. Attenuation of optical fibers shall not exceed the values calculated as follows:

1) Attenuation (max.) = 2*C+L*F+S dB.

2) Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice loss (# of splices * maximum attenuation per splice).

2. Verification of Link Integrity (OTDR):

a. All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.

b. Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.

c. OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

2.03 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, submit as-builts per the requirements of Section 27 0500 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.

3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (USB thumb drive). The thumb drive shall contain the electronic equivalent of the test results as defined by the bid specification and be in the tester's native format as well as summaries of each test in pdf format. Provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. Furnish one (1) copy of the data and display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 27 1720
STRUCTURED CABLING SYSTEM WARRANTY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

1.02 RELATED WORK

A. Section 27 0500 - Basic Communications Systems Requirements.

B. Section 27 1100 - Communication Equipment Room (CER).

C. Section 27 1300 - Backbone Cabling Requirements.

D. Section 27 1500 - Horizontal Cabling Requirements.

1.03 QUALITY ASSURANCE

A. Refer to Section 27 0500 for relevant standards.

1.04 SUBMITTALS

A. Under the provisions of Section 27 0500 and Division 1, prior to close of the project the Contractor shall submit:

1. A numbered certificate from the manufacturing company registering the installation.

PART 2 - PRODUCTS

2.01 WARRANTY

A. A twenty (20) year Product Installation Warranty shall be provided for the structured cabling system as described in the contract documents.

B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

C. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.

PART 3 - EXECUTION

3.01 WARRANTY REQUIREMENTS

A. This Contractor shall be responsible for providing, installing and testing a structured cabling system that will meet the manufacturer's warranty requirements.

END OF SECTION

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SECTION 27 5113
PAGING SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wall-Mounted Compression Horn, Weather Resistant

B. Paging System Cable

C. Conduit

D. Non-Continuous Cable Hangers and Supports

1.02 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 26 0535 - Surface Raceways

C. Section 26 0513 - Wire and Cable

D. Section 27 0500 - Basic Communications Systems Requirements

E. Section 27 0526 - Communications Bonding

F. Section 27 0528 - Interior Communication Pathways

G. Section 27 1500 - Horizontal Cabling Requirements

H. Section 27 0553 - Identification and Administration

1.03 QUALITY ASSURANCE

A. Installer: The Contractor must be a factory-authorized service and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1. The Contractor shall own and maintain all tools and equipment necessary for successful installation and testing of the system and have personnel adequately trained in the use of such tools and equipment.

B. Service: The installer must be factory certified to provide service on the installed manufacturer's equipment and must have local service representatives within 100.

C. The entire installation shall comply with all applicable electrical and safety codes. All applicable devices, equipment, and cabling shall be listed by Underwriters' Laboratories, Inc.

1.04 REFERENCES

A. ADA - Americans with Disabilities Act

B. ADAAG - Americans with Disabilities Accessibility Guidelines

C. NFPA 70 (NEC) – National Electrical Code

D. UL 813 - Standards for Commercial Audio Systems

E. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

F. Code of Federal Regulations Title 29 Subtitle B Chapter XVII Part 1910 Subpart L Section 1910.165 - Employee Alarm Systems

G. ISO R 266-1997

H. ANSI S1.6-1984

1.05 SUBMITTALS

A. Submit product data under the provisions of Section 27 0500.

B. Provide materials documenting experience requirements of the manufacturer and installing contractor.

C. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item by item.
2. All component options and accessories specific to this project.
3. Electrical power consumption rating and voltage.
4. Heat generation for all power consuming devices.
5. Wiring and connection requirements.
6. Manufacturer's installation instructions, indicating application conditions and limitations of use as stipulated by product testing agency and instructions for storage, handling, protection, examination, preparation, installation, and initiating usage of product.

D. Certification Documentation Submittal:

1. Provide documentation of all required certifications. All certifications shall be current and valid. Any certificate with expired dates will not be accepted. Submittal shall include documentation of the following:
   a. System Equipment Manufacturer(s) dealer certification(s) and dealer number(s).
   b. System Equipment Manufacturer(s) programmer certification(s).
   c. All other applicable dealer, installation, and programming certifications.
2. If an alternate manufacturer is submitted, the equivalent certifications to the basis of design manufacturers shall be required and submitted.

E. Provide voltage drop calculations for each speaker cable circuit or run, showing the drop for the specific circuit or run wattage and cable size used.

F. Quality Assurance:

1. Provide list of test equipment proposed for use in testing the installed paging system.
2. Provide system checkout test procedure to be performed at acceptance, including demonstration of specified performance and all required system features and functions listed herein and as further detailed on the drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 0500.

B. Store and protect products under the provisions of Section 27 0500.

1.07 SYSTEM DESCRIPTION

A. This specification section describes the extension of an existing single-zone paging system.

B. Performance Statement: This specification section and the accompanying design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed or every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required for a complete and operational system.

C. This Contractor shall furnish and install paging system speakers as hereinafter specified and further detailed on the drawings. System shall be completely wired and ready for use including, but not limited to, outlet boxes, conduit, wire, equipment and speakers.

1.08 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 0500.

B. Provide floor plans identifying actual locations of all installed overhead paging system equipment and devices.

C. Provide final system block diagram showing any deviations from shop drawing submittal. Block diagram shall include cable number documenting the numbers installed on both ends of the cable in the field.

D. Provide documentation of all test results and statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described herein.

1.09 WARRANTY

A. Unless otherwise noted, provide warranty for a minimum of one (1) year after Substantial Completion, as defined by the Contract. Certain system components may require additional manufacturer's warranty as described herein.

B. The warranty shall:

1. Ensure that all approved devices, equipment, cabling, and other components specified in this section meet or exceed the specified requirements.
2. Ensure against product defects.
3. Cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

C. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - PRODUCTS

2.01 WALL-MOUNTED COMPRESSION HORN, WEATHER RESISTANT

A. Features:

1. Integral 70-volt transformer
2. Weather-resistant molded grey plastic enclosure
3. Integral U-bracket mount

B. Specifications:

1. Power Handling: 15 watts, minimum of 5 transformer tap settings
2. Frequency Response: 400 Hz to 14 kHz
3. Sensitivity: 89 dB

C. Basis of Design:

1. Atlas AP-15T

D. Provide complete with necessary manufacturer's mounting accessories.

2.02 PAGING SYSTEM CABLE

A. Speaker Cable

1. Minimum 18/2 shielded with drain wire
   a. Conductor Type: Bare copper, stranded
   b. Voltage Capacity: 300 volts RMS
   c. Current Capacity: 5 amps per conductor
   d. Nominal Capacitance, Conductor to Conductor: ä? 70 pF/ft.
   e. Nominal Capacitance, Conductor to Shield: ä? 126 pF/ft.
   f. UL Temperature Rating: 75°°C
2. Cable shall be NEC compliant and UL listed.
3. Basis of Design:
   a. Belden 5300FE (CM) or 6300FE (CMP)

4. Provide with larger-gauge conductors where necessary to maintain acceptable voltage drop as defined herein.

2.03 CONDUIT

A. All conduit for paging system cabling shall be a minimum of 3/4" trade size.

B. Flexible conduit shall be used only for "fixture whip" type applications at speakers in accessible ceilings, between a speaker and nearby junction box. Flexible conduit for this application shall be no longer than four (4) feet. Flexible conduit shall not be installed for any other paging system cabling.

C. Refer to Specification Section 26 0533 for additional requirements.

2.04 NON-CONTINUOUS CABLE HANGERS AND SUPPORTS

A. Refer to Section 27 0528 for requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with all manufacturer's instructions and recommendations for installation of all equipment, devices, and materials.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. Wiring:

1. Refer to Sections 26 05 33 for conduit requirements and 26 05 13 for additional wiring requirements. Wiring not installed in conduit shall be plenum rated.
2. All cabling shall be run in conduit "free-air" in non-continuous cable supports or cable tray above accessible ceilings, and in conduit or in a secured metal raceway in exposed areas. Supports shall be spaced at a maximum 4-foot interval. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.
3. All overhead paging system audio cabling, including but not limited to speaker, line-level audio, and microphone-level audio cabling, shall be installed in its own cable pathway and shall not share any raceway or cable pathway with telephone or computer network cabling or cabling of any other system.
    a. Cable shall not be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires. Cables shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, ceiling supports, electrical or communications conduit, or structural elements.
4. Manufacturer's minimum bend radius specifications for cables shall be observed in all instances.
5. All cable shall be installed at right angles and be kept clear of work by other trades. To reduce or eliminate EMI, the following minimum separation distances from £ 480V power lines shall be adhered to:
    a. 12 inches from power lines of 5-kVa
    b. 18 inches from high voltage lighting (including fluorescent)
    c. 39 inches from power lines of 5-kVa or greater
    d. 39 inches from transformers and motors
6. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.
7. All cable shall be free of tension at both ends.
8. Both ends of all cables shall be clearly labeled with an alphanumeric identifier. On speaker cables, the label shall indicate the speaker cable circuit zone or run and the telecommunications room in which the zone or run initiates; on line-level cables, the label shall indicate the signal and signal source. Record all speaker cable identifiers on record drawings.
9. No acid core or other corrosive flux solder shall be used in this system.

10. Speaker cable conductor sizes listed are minimum requirements. Actual wire size required shall be determined by the Contractor to maintain a maximum of 10% voltage drop or 0.5 dB insertion loss on any speaker zone. Actual speaker cabling installed shall meet or exceed minimum conductor sizes listed. Basis of design paging speaker cable listed herein is provided to list the minimum criteria and performance requirements for paging speaker cable.
11. The polarity of all cabling shall remain consistent throughout the project, on all equipment.
12. Do not run unbalanced audio signals over cables longer than 10 feet. Contractor shall provide a shielded transformer-based converter at signal source to convert the unbalanced signal to a balanced signal.
13. The Contractor shall provide an isolation transformer for any balanced or unbalanced audio line that exhibits hum, EMI / RFI, power line noise, or ground loops.
14. Provide all system wiring between all components as shown on project documents, as directed by the manufacturer, and/or required for proper system operation and to provide specified system functionality.

D. Equipment:

1. All necessary devices, sub-components, accessories, and incidental materials required to provide a complete, turn-key paging system that provides specified performance and all required system features and functions listed herein and as further detailed on the drawings shall be provided and installed as part of a complete system.
2. All speakers shall be connected in proper polarity.
3. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tools recommended by the manufacturer for that purpose. Use caution to avoid stripping or damaging connectors, terminals, or equipment by over-tightening termination fasteners.
4. The conductor color code used in terminating system cabling at system equipment and devices shall remain consistent from device to device for each unique device type throughout the project.

E. Grounding Requirements:

1. Furnish and install a minimum #6 AWG bonding conductor from each overhead paging system head end component to the nearest wall-mounted telecommunications grounding busbar. Actual bonding conductor size determined by its installed length. Refer to Section 27 0526 for grounding and bonding conductor sizing criteria.
2. Audio cable shields for line level signals shall be connected to the metal equipment chassis at both ends of the cable. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.
3. Speaker cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground speaker cable shields at signal origin telecommunications room end only.

3.02 SYSTEM SETUP, PROGRAMMING, AND ADJUSTMENT

A. The Contractor shall provide all system balancing, tuning, and adjustment required as part of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments that may be required.

B. Paging system shall be adjusted to provide 85 measured at one (1) meter from each speaker when voice pages are made. Sound shall be clear, even, and undistorted and free of any hum, noise, or sonic anomalies. Where speakers are controlled via local volume controls, adjustments shall be made with the volume control set at 70

3.03 TESTING

A. The Contractor shall conduct all system testing as part of the requirements of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments or corrective action that may be required to provide a complete system that provides the specified performance and all required system features and functions listed herein and as further detailed on the drawings.

B. At a minimum, the installer shall perform the following inspections and tests of the installed overhead paging system:
   1. Verify that all features and functionality are operating properly.
   2. Verify that the system receives signal from all sources and routes those signals as specified.
   3. Verify that priority override hierarchy functions properly and according to the hierarchy specified.
   4. Verify that system output meets specified sound level at each speaker.

C. Document all test results and submit as part of final system documentation package.

END OF SECTION

SECTION 28 0500
BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.02 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.

B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make the portion of the security systems a finished and working system.

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Description of systems include but are not limited to the following:

1. Extension of existing electronic access control system
2. Fire detection and alarm.
3. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.
4. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".
5. Firestopping of penetrations of fire-rated construction as described in Division 7.

1.03 OWNER FURNISHED PRODUCTS

A. Existing access control system managed by Owner security vendor Accurate Controls, Inc.

B. Video surveillance cameras and recording equipment provided by Owner’s security contractor. Scope of work is rough-in and data cabling only.

1.04 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. Itemize all work and list associated hours and pay scale for each item.

1.05 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.

2. "Electrical Contractor" shall also refer to the Contractor listed in Division 28 of this specification when the "Suggested Matrix of Scope Responsibility" indicates the work shall be provided by the EC. Refer to the Contract Documents for the "Suggested Matrix of Scope Responsibility".
3. "Security Contractor" as referred to herein refers to the Contractors listed in Division 28 of this Specification.
4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.

C. General:

1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to security systems including back boxes, conduit, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.
2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.
4. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
    a. Lighting Fixtures
    b. Gravity Flow Piping, including Steam and Condensate
    c. Sheet Metal
    d. Electrical Busduct
    e. Sprinkler Piping and other Piping
    f. Conduit and Wireway
    g. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.
2. Responsible for Security Systems grounding and bonding.
3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."

3. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

1.06 COORDINATION DRAWINGS

A. Definitions:
1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
d. Maintenance clearances and code-required dedicated space shall be included.
e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
a. Scale of drawings:
1) General plans: 1/4 Inch = 1 '-0" (minimum).
2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.
9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
    b. Potential layout changes shall be made to avoid additional access panels.
    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
    e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.07 QUALITY ASSURANCE

A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.
3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.
5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:
    a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

B. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of Iowa’s Codes, Laws, Ordinances and other regulations having jurisdiction.
2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.
3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.
6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

C. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.

7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
   a. Factory Mutual
   b. Underwriters' Laboratories, Inc.

D. Examination of Drawings:
1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

E. Electronic Media/Files:
1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
4. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
5. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
6. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
7. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

F. Field Measurements:
1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.08 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
28 13 00	Electronic Access Control

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Division of work (e.g., plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Division of work (e.g., plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor's review stamps
3. Composition:
   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:
    a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
    b. Unstamped submittals will be rejected.
    c. The Contractor's review shall include, but not be limited to, verification of the following:
        1) Only approved manufacturers are used.
        2) Addenda items have been incorporated.
        3) Catalog numbers and options match those specified.
        4) Performance data matches that specified.
        5) Electrical characteristics and loads match those specified.
        6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
        7) Dimensions and service clearances are suitable for the intended location.
        8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
        9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
    d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
    e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
    a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
    b. The Contractor shall clearly indicate the size, finish, material, etc.
    c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
    d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
    a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. Submittal file name: 28 XX XX.description.YYYYMMDD
    b. Transmittal file name: 28 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.09 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:
1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:
1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
    a. Material: Delivered cost of product with taxes paid.
    b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
    a. Overhead and profit.
    b. Bonds.
    c. Insurance.
    d. General Requirements: Itemize all requirements.

4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    a. Security systems:
        1) Surveillance
        2) Access control

D. Update Schedule of Values when:
1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.10 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.

C. Change order work shall not proceed until authorized.

1.11 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
1. Firestopping, including mechanical firestop systems.

1.12 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.13 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.14 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.

B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.15 INSURANCE

A. Contractor shall maintain insurance coverage as set forth in Division 0 of these specifications.

1.16 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.01 Refer to individual sections.

PART 3 - EXECUTION

3.01 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 0533. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.03 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 28 sections for further requirements.
2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.04 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.
2. Refer to the end of Section 27 0500 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."
3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
2. Submitted bound copies of approved shop drawings.
3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.
4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
5. Submitted testing reports for all systems requiring final testing as described herein.
6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to the project site; submit receipt to Architect/Engineer prior to final payment being approved.

3.05 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
    a. O&M file name: O&M.div28.contractor.YYYYMMDD
    b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.06 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

D. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.

E. Refer to the individual specification sections for minimum hours of instruction time for each system.

F. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.
2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.07 SYSTEM STARTING AND ADJUSTING

A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.08 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record actual routing of all conduits sized 2" or larger.

E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.09 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

END OF SECTION

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SECTION 28 1300
ELECTRONIC ACCESS CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Portal Devices

1.02 RELATED WORK

A. Section 08 7100 - Door Hardware

B. Section 11 1900 - Detention Security Equipment

C. Section 26 0533 - Conduits and Boxes

D. Section 27 0528 - Interior Communication Pathways

E. Section 28 0500 - Basic Electronic Safety and Security System Requirements.

F. Section 28 3100 - Fire Detection and Alarm Systems.

1.03 QUALITY ASSURANCE

A. Access Control Contractor:

a. System shall be provided by Owner security vendor Accurate Controls, Inc. Refer to "Suggested Matrix of Responsibility" for rough-in and power requirements by Electrical Contractor.

B. Material:

1. All material which is Contractor furnished shall be new, unused and free from defects.
2. Where more than one of any specified item of equipment or material is used, all such items shall be the same product from the same manufacturer.

1.04 REFERENCES

A. International Building Code

B. NFPA 70 - National Electrical Code.

C. UL 294 - Standard for Access Control Systems.

D. UL 1449 - Standard for Surge Protective Devices.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 28 0500.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.
2. All component options and accessories specific to this project.
3. Wiring requirements.

C. System Drawings: Project-specific system CAD drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where each controller will be located. This block diagram shall be provided in Adobe PDF.
2. Provide a schedule of all controllers and the doors/points each controller controls. This schedule shall be provided in Adobe PDF.

3. Provide schedules describing each system input location by an architecturally familiar reference, e.g., Door 312A. The architectural door schedule shall be used as the basis. These schedules shall be provided in Adobe PDF

D. Submit sample format of site specific programming guides to be used for system planning/programming conference with Owner. These guides shall be provided in Adobe PDF.

E. So that required Owner personnel are present at the planning/programming conference required in Part 3 of this section, submit meeting agenda for the conference a minimum of two weeks prior to the conference.

F. Submit detailed description of Owner training to be conducted at project end, including specific training times. Refer to Part 3 of this section for details.

G. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and Installing Contractor. Provide documentation of the training and other applicable certifications of the Contractor.

2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.

1.06 SYSTEM DESCRIPTION

A. This section describes the devices and cabling for an extension of an existing access control system. The terms "access control system" and "security management system", or SMS, may be used interchangeably herein.

B. The company, manufacturer, and product names used in this section are for identification purposes only. All trademarks and registered trademarks are the property of their respective owners.

C. Performance Statement: This section and the accompanying access control-specific design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required. The Contractor shall be responsible for determining quantities of materials required for a complete and operational system. Floor plan drawings and schedules have been developed to aid the Contractor in determining device quantities and installation locations, but, where discrepancies between floor plans and schedules arise, the greater number shall govern.

1.07 OWNER FURNISHED MATERIAL

A. Data circuit / internet service

B. Existing computer network equipment:

1. Routers

2. Switches

3. Wireless access points

4. Uninterruptible power supplies for Owner furnished products

C. Existing access control equipment:

1. SMS server and control panel(s)

2. SMS workstation(s)

1.08 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 28 0500.

B. Provide final system block diagram showing any deviations from shop drawing submittal.

C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.

D. Provide schedules documenting:
   1. Controller installation locations including specific door numbers being controlled.
   2. All terminal block wiring, including cable numbers.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance data manuals as described below.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 28 0500.

B. Manuals:
   1. Hardware Manual: The manual shall describe all equipment furnished including:
      a. General description and specifications.
      b. Installation and check out procedures.
      c. System and equipment layout and electrical schematics to the control board and field device level. For multiple devices wired identically, only one wiring diagram is required per door configuration, to be labeled "TYPICAL".
   2. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, cleaning, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.10 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.
   1. Inspections: The Contractor shall perform two minor inspections at six-month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.
   2. Minor Inspections: These inspections shall include:
      a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
      b. Mechanical adjustments if required on any mechanical or electromechanical devices.
   3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:
      a. Clean all equipment, including exterior surfaces and accessible and serviceable interior surfaces.
      b. Perform diagnostics on all equipment.
      c. Check, test, and calibrate (if required) all sensors.
      d. Run all system software diagnostics and correct all diagnosed problems.

C. Operation: Upon the completion of any scheduled adjustments or repairs, Contractor shall verify operation of the SMS.

D. Records, Logs and Work Requests: Contractor shall keep records and logs of each task completed under and outside of warranty. These logs shall be maintained in Microsoft Word or Excel. The log shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, description of work performed, the amount and nature of the material used, and the time and date of commencement and completion of the work. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the SMS. The Contractor shall deliver a record of the work performed within three (3) business days after work is completed. Defective items that have been replaced shall be given to the Owner. Should the

replacement item be a temporary replacement until the removed item is repaired, Contractor shall retain possession of the defective item for repair and subsequent re-installation.

E. System Modifications: Modifications by the Contractor are allowed after system acceptance. Contractor shall make recommendations for system modification in writing to the Owner. No system modifications shall be made without prior, written approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Manuals, and other documentation affected. The Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

F. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - PRODUCTS

2.01 PORTAL DEVICES

A. Cable:

1. Composite cable is allowed, although sufficient conductors may not be available in composite cables for all portal configurations. Contractor shall be responsible for additional required cables beyond one composite cable to each portal to meet functional requirements of the system.
    a. Door Position Switch: 22 AWG, 2 conductor, stranded.
    b. Lock: Minimum 18 AWG, 4 conductor, stranded.
        1) Lock may require heavier gauge cable depending on door hardware solution power requirements. Contractor shall coordinate with detention equipment subcontractor for higher current devices and shall adjust the gauge of the lock cable accordingly.
    c. Auxiliary Devices: Refer to plans for requirements.

B. Locks and Door Hardware:

1. Electric/electronic locks shall be furnished and installed by the detention equipment subcontractor.
2. Contractor shall interface with and terminate cables to locks.
3. Contractor shall coordinate with detention equipment subcontractor for specified sequences of operation at the various portals.
4. Refer to architectural specifications 08 71 00 and 11 19 00, and/or the architectural door schedule.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.

C. Provide wiring and connection to all electrified locking hardware devices. Complete programming and testing of all electrified locking hardware devices.

D. Install all door alarm contacts in accordance with manufacturer's instructions either recessed in the door header or surface mounted as required. Provide wiring and connection to door alarm contact devices. Complete programming, adjustment and testing of all door alarm contacts.

E. Install, wire, configure, adjust, program and test all access control system equipment.

F. All low voltage access control cabling shall be routed and supported completely separate from any and all other telecommunications or other low voltage system cabling.

G. Electronic access control system cabling shall not be spliced.

H. Flexible conduit is not allowed except with prior approval. Refer to Section 26 0533 for conduit requirements. Refer to Section 27 0528 for cable hanger and support requirements.

I. Each cable shall be appropriately identified, as defined on the record documents, at each end's termination point using pressure sensitive label strips.

J. The conductor color code used in terminating system cabling at system devices shall remain consistent from device to device for each unique device type throughout the project.

K. Install and tighten all connectors in accordance with manufacturer's instructions using the appropriately designed tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, or equipment by over tightening termination fasteners.

L. Grounding and Bonding Requirements:

1. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the control panel end.

M. Coordinate installation of all devices with other trades and utilities in the vicinity.

N. Cabling shall be plenum rated when installed outside conduit in plenum ceilings.

3.02 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL) as suitable for purpose specified and indicated.

3.03 MANUFACTURER AND INTEGRATOR COMBINED FIELD SERVICES

A. Installation shall be performed by a factory-trained and certified Contractor.

B. The Contractor shall provide a comprehensive, site-specific customer planning guide for the system. The Contractor shall conduct conference(s) with the Owner prior to any installation to discuss the programming and configuration options of the system and the planning guide.

C. The Contractor shall include labor for all planning and all programming activities required to implement the Owner's access policies for each system point and each operator and administrator. Any software programmable access policy, within the bounds of the hardware specified, shall be included.

D. The SMS Installation Contractor shall be present at meetings to coordinate all door hardware requirements with the detention equipment subcontractor.

3.04 SYSTEM DOCUMENTATION

A. The following sections shall be provided in the system documentation:

1. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.

2. Refer to Part 1 for details.

3.05 SYSTEM ACCEPTANCE

A. The SMS vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components, software and functionality. The Contractor shall perform the tests and document all results under the supervision of the manufacturer's systems engineer.

B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

C. The system shall not be accepted until all requirements of system documentation and training have been completed.

END OF SECTION

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SECTION 28 2300
VIDEO SURVEILLANCE

(VIDEO SURVEILLANCE EQUIPMENT PROVIDED AND INSTALLED BY OWNER. SPECIFICATION PROVIDED AS REFERENCE ONLY.)

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Network Video Management System (NVMS).

B. Video Storage Solution

C. Cameras and Accessories.

D. Cabling.

1.02 RELATED WORK

A. Section 26 0533 - Conduit and Boxes

B. Section 26 0513 - Wire and Cable

C. Section 27 1500 - Horizontal Cabling Requirements

D. Section 28 0500 - Basic Electronic Safety and Security System Requirements

E. Section 28 3100 - Fire Detection and Alarm Systems

1.03 QUALITY ASSURANCE

A. NVMS Software Developer (Manufacturer): The NVMS system shall be a single-source manufacturer such that the single manufacturer develops, supports, and warranties the NVMS software solution.

B. Integrator/Installer (Contractor): The Contractor must be a NVMS-certified installation, service, and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1.04 REFERENCES

A. NFPA 70 - National Electrical Code

B. Electronic Industries Association (EIA) Video Surveillance Equipment Standards

C. UL 2044 - Standard for Commercial Closed Circuit Television Equipment

D. UL 3044 - Standard for Safety for Surveillance Closed Circuit Television Equipment

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 28 0500.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents.
2. All component options and accessories specific to this project.
3. Electrical power consumption rating and voltage.
4. Heat generation for all power consuming devices.
5. All required wiring shall be identified.
6. Number of IP addresses that will be required from the Owner's Information Systems Department.
7. Statement of Acceptability of Designed Server:
    a. If the Contractor agrees that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution and meets the demand of the application, this shall be stated in writing and submitted as part of the shop drawing submittal.

b. If the Contractor does not agree that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution, Contractor shall itemize the quantity, technical specifications, and capacities of the servers required to support the functionality and device quantities required by the project drawings. Indicate the capacity utilization factor for each server.

c. Contractor's bid shall include any required changes in server(s) capacity.

8. Calculation for storage required using the criteria contained in the project drawings.

9. Calculation for required network bandwidth, including any latency restrictions.

10. Provide annual cost and all terms and conditions for the NVMS Software Maintenance Agreement. Include all additional costs and terms and conditions for any Annual Service Contracts provided by the Contractor for all services that are not included in the Software Maintenance Agreement.

C. System Drawings: Project-specific system CAD drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical cameras), the diagram may show one device and refer to the others as "typical" of the device shown.

D. Sample format of site specific programming guides to be used for system planning/programming conference with Owner.

E. Meeting agenda for planning/programming conference required in Part 3 of this specification.

F. Submit detailed description of Owner training to be conducted at project end, including specific training time.

G. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and installing contractor.

2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.

H. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 28 0500 for coordination drawing requirements.

1.06 SYSTEM DESCRIPTION

A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey, closed circuit television system.

B. Performance Statement: This specification section and the accompanying project drawings are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

C. Refer to the project drawings for model numbers for the Basis of Design for all equipment.

1.07 LICENSING REQUIREMENTS

A. All licenses required for system operation shall be included in the Contractor's bid. Licenses shall include, but not be limited to, server and workstation software, cameras, encoders/decoders, and any other licensing that is required by the manufacturer for operation of any system component.

1. Camera licenses shall be provided for all cameras listed on the drawings.

2. The Contractor shall fill out the NVMS Bid Inventory Form located herein and provide at the time of bid.

1.08 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 28 0500.

B. Provide final system block diagram showing any deviations from shop drawing submittal.

C. Provide statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

D. Provide final camera type and camera requirements schedules documenting all changes made during construction.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described below.

1.09 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 28 0500.

B. Manuals: Final copies of the manuals shall be delivered within 14 days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the manufacturer for each piece of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

1. Hardware Manual: The manual shall describe all equipment furnished including:
    a. General description and specifications.
    b. Installation and check out procedures.
    c. System layout drawings and schematics.
    d. Alignment and calibration procedures.
2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper installation, testing, and operation. The manual shall include:
    a. Definition of terms and functions.
    b. System use and application software.
    c. Graphical user interface use.
    d. Reports generation.
3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:
    a. Computers and peripherals.
    b. System startup and shutdown procedures.
    c. Use of system.
    d. Recovery and restart procedures.
    e. Use of report generator and generation of reports.
    f. Data entry.
    g. Operator commands.
    h. Alarm messages.
    i. System permissions functions and requirements.
4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.10 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: Perform one minor inspection six-months after Substantial Completion and one major inspection prior to the expiration of the warranty.
2. Minor Inspections: Inspections shall include:
    a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
    b. Mechanical adjustments if required on any mechanical or electromechanical devices.
    c. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.
3. Major Inspections: Inspections shall include all work described under paragraph Minor Inspections and the following work:
    a. Clean all equipment, including interior and exterior surfaces.
    b. Perform diagnostics on all equipment, including all system software diagnostics, and correct all diagnosed problems.
    c. Adjust all camera alignments that have become out of alignment from their documented position at Substantial Completion.
    d. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.
    e. All warrantable system deficiencies during the Major Inspection shall be remedied under warranty at no cost to the Owner.

C. Operation: Upon the performance of any scheduled adjustments or repairs, verify operation of the NVMS system.

D. Emergency Service: The Owner will initiate service calls when the NVMS system is not functioning properly. Qualified personnel shall be available to provide service within the distance defined above. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365.

E. Records and Logs: Keep records and logs of each task completed under warranty. The log shall contain all initial settings upon Substantial Completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the NVMS system.

F. Work Requests: Record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what must be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within five (5) days after work is accomplished.

G. System Modifications: Make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

H. Software: Provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with NVMS system operators, shall include training for the new changes/features enabled, and shall be incorporated into the operations and maintenance manuals, and software documentation.

I. Refer to the individual product sections for further warranty requirements of individual system components.

1.11 SOFTWARE MAINTENANCE AGREEMENT/ANNUAL SERVICE CONTRACT

A. Provide annual cost and all terms and conditions for the Software Maintenance Agreement (SMA) provided by the NVMS manufacturer and/or the Contractor.

B. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services. The cost and terms of the SMA ***may*** be used by the Owner for NVMS solution selection.

PART 2 - PRODUCTS

2.01 NETWORK VIDEO MANAGEMENT SYSTEM - GENERAL REQUIREMENTS

A. The network video management system (NVMS) shall be an enterprise-class client/server-based video security solution that provides management of digital video, audio and data across a TCP/IP network.

B. Provide a turnkey solution that includes furnishing, installation, and configuration of a separate IP network, complete with all required network electronics, switches, and other hardware.

C. ONVIF Compliance:

1. The NVMS system shall be ONVIF certified as an ONVIF Network Video Client.
2. Cameras shall be ONVIF certified as an ONVIF Network Transmitter unless specifically noted as an exception to this requirement in the project drawings.

D. The NVMS system shall be an "open system."

1. To meet this requirement, the NVMS must directly support cameras from a minimum of three (3) readily available camera manufacturers.
2. The three (3) camera manufacturers must have no corporate relationship to the NVMS manufacturer.
3. "Directly support" shall be defined as plug-n-play using drivers that are commercially available at the time of bid that utilize the ONVIF specification as the means of integration.
4. In addition to the requirement to support three (3) independent manufacturer's cameras, the NVMS may support an unlimited additional quantity of in-house or other proprietary cameras.
5. The open system shall not require proprietary storage solutions. It shall support third party storage solutions, including:
    a. Commercially available Direct Attached Storage (DAS) devices.
    b. Network Attached Storage (NAS) devices.
    c. Storage Area Networks (SAN) for ***primary*** or archival storage purposes. Primary support for SAN shall be defined as:
        1) The ability to directly record to SAN device without first recording to an NAS or DAS.
        2) The NVMS is provided with a user experience that makes the video recorded to the SAN transparent to the user. This shall be defined as:
            a) Full search, bookmarking, and other software features for finding, marking, locating, and identifying video are supported by the NVMS for video recorded to a SAN in an identical way to video that is recorded to an NAS or DAS.
            b) No loading of the video from the SAN into the NVMS shall be required.
            c) Full playback, windowing of camera video, archiving, and exporting is supported by the NVMS for video recorded to the SAN in an identical way as video recorded to an NAS or DAS.
6. The system must have a published API/SDK permitting third party integrations to the product without restrictions.
7. The NVMS shall support active directory using LDAP protocol.

E. The NVMS system shall consist of the following hardware/software components:
   1. Software:
      a. Server and client
      b. Recording services, archival services, and storage management
      c. Configuration tools
   2. System storage as specified on the project drawings.
   3. Cameras and related hardware as specified on the project drawings.
   4. Hardware: Servers, workstations, and miscellaneous hardware (keyboard, mouse, KVM) as specified on the projects drawings.
   5. Network electronics and related hardware and software as specified on the project drawings.

F. Video from any camera on the system (on the LAN, WAN or Internet) shall be capable of being viewed from single or multiple workstations simultaneously at any time, limited only by network bandwidth.

G. The NVMS shall support simultaneous displaying of live (30 fps) video of a minimum of 16 cameras while the video monitoring screen is configured in a 16-camera split configuration. In no case shall the frame rate of the camera be required to be restricted to less than 30 fps to display a 16-camera split view.

H. Simultaneous display and recording of every camera shall be supported with independent user-adjustable frame rates that can be set differently for the display stream and the recording stream. These independent settings shall be unique per camera.

I. The NVMS monitoring software shall support any combination of recorded and live video in any multiple camera split view, including viewing recorded video and live video from the same camera.

J. The NVMS shall support continuous recording and event-based recording simultaneously. This shall be capable of being set on a per camera basis.

K. Viewing of video (live and recorded) shall be possible from client software from any client hardware that is connected to the security LAN/WAN or Internet (through appropriate firewalls). In addition, system administration shall be permitted from remote client hardware.

2.02 NVMS MANUFACTURERS

A. Basis of Design:
   1. Pelco
   2. Preapproved Equal

2.03 NVMS SERVER REQUIREMENTS

A. The server shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 100/1000BaseT.

B. The server shall be provided by the NVMS system vendor.

C. The server(s) requirements have been calculated based on the NVMS Basis of Design manufacturer noted above. By submitting a bid, the Contractor acknowledges that the calculated server requirements listed here may not be sufficient for a listed alternate, acceptable manufacturer selected by the Contractor. The Contractor shall modify the calculated server requirements listed herein based on the calculated requirement of the chosen manufacturer. The server requirements for the basis of design are as follows:
   1. Server Quantity and Location: Refer to project drawings for quantity of servers required and their location.

D. All licensing shall be included in the Contractor's bid.

2.04 NVMS SYSTEM DETAILED REQUIREMENTS

A. Network Requirements: The NVMS shall support Ethernet 10/100 BaseT and Gigabit Ethernet.
   1. Network protocols shall be supported including TCP/IP, IPX, and UDP.
   2. The network interface shall allow remote access of the NVMS from anywhere on the end-user's LAN/WAN or Internet (behind firewall).

3. The system shall permit limiting of frame rate transmission to individual clients.
4. Both Multicast and Unicast shall be supported.
5. All transmission of system data shall be secured using Secure Socket Layer (SSL) security on the TCP/IP network.
6. Simple Network Management Protocol (SNMP) shall be supported.

B. Video Formats:

1. The NVMS shall support MJPEG, JPEG2000, MPEG-4, H.264 and H.265 compression formats.
2. The system shall support any single stream of bandwidth up to 90Mbit/sec at 30 fps at 4872 x 3248 resolution with no system performance degradation, assuming appropriate network bandwidth.
3. Video shall be recorded using a 256-bit encryption algorithm with authentication (watermarking) software suitable for evidentiary proceedings. The watermarking feature shall provide evidence of altered video.
    a. The video shall be watermarked with the authentication key/signature during recording of live video to the drive.
    b. A video player shall be provided with the NVMS system.
        1) The player shall have the ability to validate the authentication upon playback.
        2) This authentication shall provide the storage media name, camera name, video time, and user information.
        3) The authentication shall have the ability to be password protected.
4. Resolution:
    a. The camera resolution shall be user selectable on a per-camera basis. Selecting or changing resolution shall not require a restart of the application, server, or workstation.
    b. The system shall support the following resolutions:
        1) Megapixel Resolutions: SXGA (1280 x 1024: 1.3MP), SXGA + EXGA (1400 x 1050: 1.4 MP), UXGA (1600 x 1200: 1.9MP), WUXGA (1920 x 1200: 2.3MP), QXGA (2048 x 1536: 3.1MP), WQXGA (2560 x 1600: 4.1MP), QSXGA (2560 x 2048: 5.2MP), 3296 x 2472: 8MP, 4000 x 2672: 11MP, 4864 x 3248: 16MP, 6576 x 4384: 29MP.
            a) 16:9 and 4:3 formats shall be supported.
        2) HDTV Resolutions: 720p, 1080(i/p) in 16:9 format.

C. Workstation Client Software Requirements:

1. The client software for the NVMS shall run as an application on Windows 7, 10, or 11 64-bit. The client software shall not require a PC more robust than that defined above in the section entitled "NVMS CLIENT REQUIREMENTS." Should the workstation client software require a PC configuration more robust than that defined herein, the cost of upgrading the workstation hardware to the more robust requirement shall be paid by the Contractor.
2. The client software shall provide video signal detection and provide alerts whenever video is lost on any input channel.
3. Updates to the client software shall be capable of being pushed to all clients from the NVMS server.
4. The client software shall provide a graphical mapping feature. The graphical map shall accommodate the importation of CAD files, or custom development of floor plans or site plans to create a to-scale or not-to-scale graphical representation of the system layout including all cameras.
    a. Cameras located on the graphical map shall be "live," which is defined as the ability to click the camera in the graphical user interface (GUI) to see camera information and live video. The camera name shall be available to the user via a "mouse hovering" maneuver over the camera icon.

b. For site cameras, the graphical map shall consist of an overall site plan showing all exterior cameras. Buildings and other physical entities on the site shall be graphically represented.
   1) The buildings shown on the site plan shall visually indicate to the user that cameras are located inside that building's interior, if applicable.

c. The user shall be able to click a building that contains cameras to obtain a new graphical layout of that building. Once the building interior layout graphical map is on screen, interior cameras shall be represented by icons.

d. The user shall have the ability to navigate back to the main (previous) graphical map via a single-click graphical icon.

5. Camera Configuration:
   a. Each camera shall be configurable for a 32-alphanumeric character name.
   b. The system shall allow for the setup and adjustment of brightness, contrast, archiving, motion detection, and Pan/Tilt/Zoom on a per camera basis.
   c. The NVMS shall support a separate frame rate for recording and a separate frame rate for viewing for every camera input (assuming the camera provides two streams). These frame rates shall be capable of being independently set for each camera input.
   d. The NVMS shall support the PTZ control of analog NVMS cameras through the encoders.
   e. The compression algorithm formats MJPEG and MPEG4 shall be supported in the same system and shall be individually selectable on a per-camera basis.
   f. Each individual camera shall be capable of having individual camera settings that shall include (at a minimum):
      1) Continuous recording.
      2) Motion-based recording capability shall be provided including:
         a) Motion as determined by the NVMS software using:
         b) Motion as determined at the camera.
         c) Motion trigger by digital inputs from external trigger systems such as contact closures, alarm inputs, POS integration, etc.
         d) Motion triggers received by external trigger inputs shall be recorded by the event recording capabilities of the NVMS and identifiable on a timeline during playback and in reports.
      3) Alarm-initiated recording.
         a) When a camera enters alarm recording mode, the NVMS shall have the capability of changing to different camera settings for the recorded video during the duration of the alarm mode. The settings capable of being changed shall include the frame rate and the resolution. These setting changes shall be configurable in advance per camera by the User through the software GUI.
      4) Time-based recording on a preset schedule.
      5) Manual (user) activation of the start and stop of the recording process through the GUI.
         a) The NVMS software shall prevent any user from manually starting and stopping the recording of video based on that user's login credential.
      6) Defined pre-event and post-event recording buffers shall be provided for all non-continuous recording events.
      7) Each camera shall be capable of having unique storage retention settings.
   g. The NVMS shall support unidirectional audio recording utilizing the built-in audio recording capability of audio-equipped IP cameras.

D. Pan/Tilt/Zoom (PTZ) Control:
   1. The NVMS shall support PTZ control from any client, including remote and mobile clients.
   2. The following PTZ features shall be supported:
      a. Priority Levels
      b. Device Group Control
      c. PTZ Override (Lockout)
      d. Proportional PTZ Control
      e. Preset Lock via video screen
      f. Preset Tour

E. Video Archiving:
   1. The archiving feature shall be hardware independent, providing the ability to utilize commercial off-the-shelf mass storage devices as archived video destinations, including optical DVD, DAS, NAS, SAN, and other external storage drives.
   2. The archiving software shall provide the ability to manage and store video information from multiple recorded video locations to a central location.
   3. Each NVMS server shall have the ability to set its own unique archiving settings. Video shall automatically be archived based on user-defined "percentage full" settings. When the NVMS reaches the designated capacity threshold, video shall be automatically copied to the archive storage destination, and space on the source of the recorded video shall be released for overwrite by new video information using a first-in, first-out algorithm.
      a. Exception: Video marked or tagged by the user or by automated alarm inputs shall be retained by the archiving process despites its location in the first-in, first-out timeline.
   4. Regardless of the video's storage location (local or in the archive), the NVMS software shall automatically retrieve video associated with an event on demand by the user in response to a search, browse, or other retrieval action. The actual storage location of the video shall be transparent to the user.
      a. Exception: Video archived to removable media (e.g., removable hard drives or optical DVD) shall require prompting to the user to insert the appropriate media.
   5. Archiving shall be capable of being scheduled such that archiving will only run during certain hours defined by the Owner.
   6. The NVMS solution shall be permitted to utilize advanced algorithms for managing onboard storage such as reducing the frame rate of recorded video for the oldest video as an alternative to completely removing the video using a first-in, first-out algorithm. If this option exists in the NVMS software, it must have the following features:
      a. Ability of the Owner to completely disable the feature.
      b. Ability to set a minimum frame rate that the system will not exceed.
      c. Ability to set the feature on a per-camera basis.

F. The NVMS shall provide up to 10 different and independent programmable recording schedules.
   1. The schedules may be programmed to provide different record frame rates for day, night, and weekend periods, as well as holidays and exception days.
   2. Advanced task schedules may also be programmed that could specify allowed log-on times for user groups, when events may trigger alarms, and when data backups and archiving should occur.

G. The VMS shall support Dual Authorization logon. It shall function as follows:
   1. Dual Authorization user groups may be created.
   2. Logon pairs, consisting of any two normal user groups, may be assigned to each Dual Authorization user group.

3. A separate set of privileges and priorities can be assigned for each Dual Authorization user group.
4. For each user group assigned as part of a logon pair, it shall be configurable whether the group can:
    a. Log on either individually or as part of the logon pair.
    b. Log on only as part of the logon pair.
5. If a user that is part of logon pair logs on individually, then the user shall receive the privileges and priorities of the user's assigned user group. If the same user logs in as part of a logon pair, then the user shall receive the privileges and priorities assigned to the Dual Authorization group to which the pair is assigned.

H. The NVMS shall auto-discover cameras and encoders. Device detection shall support devices in different subnets.

I. The NVMS shall be designed in such a way that server downtime or loss of communication to the server does not affect the functionality of the recording services. Normal recording and motion recording shall continue during server downtime.,

2.05 NVMS RECORDING REQUIREMENTS

A. The NVMS shall provide management of the recording and playback of video, audio, and data (bookmarking, alarm data, etc.).

B. Refer to the project drawings for specific variables to be used on a per-camera basis for the purpose of calculating storage capacity and retention.
1. Total distributed storage requirements shall be determined based on a minimum of 30 days storage retention.
2. Cameras shall be assumed to be recording 24 hours per day, 7 days per week, 365 days per year. Specific per-camera assumptions stated on the drawings for percent motion shall be used in the storage calculation.
3. Compression shall be permitted to be used in the storage calculation. The compression algorithm (MPEG-4, H.264, etc.) shall be used on a per-camera basis. If the NVMS permits variable levels of compression intensity, the use of the "average" or "medium" level setting shall be used in the storage calculation unless otherwise noted.
4. The Contractor shall provide the complete storage analysis and calculation as a shop drawing.

C. Network Video Recorder (NVR) Hardware Platform:
1. The NVR shall be defined as a storage device for recording IP video streams from IP cameras or from analog cameras that have been encoded to IP. In both cases, the NVR shall record IP streams from cameras or encoders located anywhere on the IP network without being direct-cable connected to the NVR.
2. Refer to the project drawings for specific requirements, model numbers, and basis of design for the NVR.
3. NVR Configuration:
    a. The NVR shall contain one hard drive for the operating system and software, and all hard drive storage required to achieve the required storage retention.
    b. Provide with RAID 5 hard disk controller configuration for the video storage hard drives.
4. The NVMS shall provide a failover function where an NVR can be assigned as a backup to other NVRs. When an assigned NVR goes out of service, the failover NVR takes over the responsibilities of the failed NVR. When the primary NVR returns to service, the control shall be automatically transferred back to the primary NVR.
5. It shall be possible to assign a redundant NVR to every NVR for use in normal operation of all NVR(s) in the system. The redundant NVR shall record the same streams as the primary NVR. The redundant NVR shall have its own disk drives where it shall store the recorded data.

2.06 NVMS CABLING

A. Refer to Division 27 for all cabling requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.

C. Mount all cameras in the approximate locations shown on the drawings. Coordinate installation with other trades and utilities in the vicinity. Cameras containing fixed lenses, moved by more than 1'-0" from their location shown on the drawings, shall have a new lens calculation performed by the Contractor. Provide Architect/Engineer with results of lens calculation before proceeding with installation.

D. Coordinate with Owner's IT Department to acquire network connections as well as any network configuration information, such as IP numbers, that will be required to connect NVMS to Owner network (if applicable).

E. Provide all low voltage and +120 VAC power to all devices as required for proper system operation. Refer to Sections 26 05 33 and 26 05 13 for further requirements.

F. Cabling shall be plenum rated when installed outside of conduit in plenum ceilings.

3.02 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the project drawings.

C. It shall be the Contractor's responsibility to correct all inadequate picture quality issues prior to acceptance of the system.

3.03 MANUFACTURER'S FIELD SERVICES

A. Installation shall be performed by a factory-trained and certified Contractor.

1. Provide a comprehensive, site-specific customer planning guide for the system. Conduct a conference with the Owner prior to any installation to discuss the programming options of the system and the planning guide. The result of this planning guide shall be the determination of the system options for each device and for the software.

B. Include labor for all planning and all programming activities required to implement the Owner's operational preferences for each device and software. Any software programmable option, within the bounds of the capabilities of the hardware specified, shall be included.

C. Provide a complete, functional system as described by the project drawings. These responsibilities include:

1. Complete hardware setup, installation, wiring, and software configuration of the system, including all remote operator locations and all peripheral hardware.
2. Complete programming of all hardware and software options in accordance with the Owner's preferences as determined by the planning guide conference.
3. Programming of all custom graphic GUI screens including devices.
4. Complete system diagnostic verification.

D. Provide an authorized manufacturer representative to commission the system and ensure that facility-wide standards and project setup procedures are adhered to.

3.04 SYSTEM ACCEPTANCE

A. Submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components and software. Perform the tests and document all results under the supervision of the manufacturer's system engineer.

B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

3.05 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system.
2. Complete documentation of all programming and options.
3. Complete operating instructions for all hardware and software.

B. The following sections shall be provided in the system documentation:

1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.
2. User Manual: A step-by-step guide and instructions detailing all system user functions.
3. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams, and schematic diagrams.

3.06 SYSTEM TRAINING

A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.

B. Provide two weeks advanced notice of training to the Owner.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. System Administrators: A course detailing the system functions and operations. Provide configuration training on all aspects of the system.
2. Users: Provide a detailed course outlining the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, and general overview of the report hardware.
3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.

E. Minimum on-site training times shall be:

1. System Administrators: Three (3) days.
2. Users: One (1) day.
3. GUI Editing: One (1) day.

NVMS Bid Inventory Form

Item	Cost/Other
Total fixed (lump sum cost) for the entire project:	
Itemize the total fixed lump sum cost as follows:	
Software cost for NVMS including all implementation services.	
Cost for all camera hardware and associated accessories.	
Itemize software cost for the following (show the math):	
Fixed, non-reoccurring flat base cost (if any)	
Fixed, non-reoccurring per-camera licensing fee (if any)	
Recurring flat base cost (if any - do NOT include optional software maintenance agreement costs)	
Recurring flat per-camera licensing fee (if any)	
Client workstation licensing fees (if any)	
Remote Client licensing fees (if any)	
Mobile Client licensing fees (if any)	
Itemize all other license fees not included above.	
Add all required and optional software maintenance agreement costs (do NOT include in bid cost).	
Acknowledge receipt of addenda by writing addendum number to the right.	_____ through _____ inclusive

Include below Server Acknowledgement Statement per Section 28 2300, Article 2.3, Paragraph D.
List below all separate software options, licensing or other monetary features that the Integrator interprets as not being requested by this RFP, but that are available from the NVMS manufacturer for purchase. Attach separate document if needed.

END OF SECTION

SECTION 28 3100
FIRE ALARM AND DETECTION SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fire alarm and detection systems.

1.02 RELATED WORK

A. Section 26 0553 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.03 QUALITY ASSURANCE

A. Manufacturer: Company specializing in smoke detection and fire alarm systems.

B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction.

C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

1.04 REFERENCES

A. ASME A17.1 - Safety Code for Elevators and Escalators

B. NFPA 20 - Standard for Centrifugal Fire Pumps

C. NFPA 70 - National Electrical Code (NEC)

D. NFPA 72 - National Fire Alarm and Signaling Code

E. NFPA 101 - Life Safety Code

F. UL 2017 - General Purpose Signaling Devices and Systems

G. UL 217 / 268 - Standard for Smoke Alarms / Smoke Detectors for Fire Alarm Systems

H. 2018 Fire Code

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 0500 and as noted below.

1. Failure to comply with all the following and all the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.

2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.

B. Provide product catalog data sheets as shop drawings.

1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.

2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.

3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.

C. Submit CAD Floor Plans as Shop Drawings:

1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.

2. Indicate the precise routing of notification appliance circuits under the provisions of circuit survivability. Refer to "Wiring" under Part 3 - Execution of this specification section for requirements.
3. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.

D. About all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.

E. Provide installation and maintenance manuals under provisions of Section 26 0500.

F. Submit manufacturer's certificate that system meets or exceeds specified requirements.

G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.

H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.

I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a NICET Certification of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

1.06 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.
   a. Smoke and heat detectors, manual pull stations, duct smoke detectors, monitor modules, control modules and relays.
   b. Notification Appliances: Speakers, speaker strobes, and strobes.
2. Keys: The installing contractor shall collect all equipment spare keys provided with each lockable or resettable device/cabinet minimum of one (1) set each and shall turn over to the Owner upon completion.
3. All spare parts shall be housed in metal cabinet labeled "Fire Alarm Spare Parts."

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 0500.

B. Store and protect products under provisions of Section 26 0500.

1.08 REGULATORY REQUIREMENTS

A. System: UL or FM Global listed.

B. Conform to requirements of NFPA 101.

C. Conform to requirements of Americans with Disabilities Act (ADA).

D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

1.09 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.

C. Extending the Existing Fire Alarm System: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to extend the existing fire alarm system. This includes, but is not limited to, additional power supplies, initiating devices and circuits, signaling devices and circuits, monitoring devices and circuits, auxiliary control and related devices such as, door holders and their control, smoke damper control, fan shutdown, etc. The existing fire alarm system shall be extended such that the existing fire alarm system's functionality, integrity and annunciation shall be equivalent to pre-construction conditions, unless noted otherwise. The functionality and integrity shall be maintained during construction. The entire system shall be able to be completely reset from any single reset location point. The entire system shall be annunciated at any annunciation location.

D. Extending the Existing Simplex Grinnell Fire Alarm System: The existing control panel shall remain and shall be operational throughout construction. The system shall only be disabled to make new connections and to modify the programming. A fire watch shall be provided for all areas affected during outages. All system outages must be scheduled with the Owner at least one week prior. Individual devices may be disabled as needed based on construction activities to reduce the potential for false alarms, but all devices must be operational when the Contractor is not physically on site. New initiating devices may be connected to the existing signaling line circuits where capacity is available. Provide additional signaling line circuits as needed based on existing and new device quantity, including replacement of existing panel components. Provide new notification circuits to serve the new devices, including all necessary power supplies, amplifiers, batteries, and 120-volt input circuits. All new devices shall be programmed to provide the same sequence of operation as the existing devices of the same type, unless noted otherwise.

E. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.

F. In-Building Network: A complete fire alarm system network shall be provided. Provide quantity of control panels as indicated on the drawings. The network shall be a Style 7 token ring, peer-to-peer network. The network shall be characterized by simultaneous or sequential transmission, or both, and reception of multiple signals on a signaling line circuit or communication channel. The distributed intelligent characteristic of the network shall provide for all nodes independently making pertinent system decisions with no need for a central controller. Each node shall be capable of independent operation should loss of network communications occur. In no case shall read-only network annunciation be acceptable as the only networking function.

G. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.

H. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.

I. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.

J. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.

1.10 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 26 0500.

B. Include location of end-of-line devices.

C. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.

D. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.

1.11 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 26 0500.

B. Include operating instructions, and maintenance and repair procedures.

C. Include results of testing of all devices and functions.

D. Include manufacturer's representative's letter stating that system is operational.

E. Include the CAD floor plan drawings.

F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

1.12 DOCUMENT STORAGE CABINET

A. The cabinet shall have all fire alarm system documents, including record drawings, wiring diagrams, operation manuals, etc. A legend sheet permanently attached to the door shall contain system passwords and inspection logs. The enclosure shall also provide two (2) key ring holders for system keys and a location for a standard size business card with service contact information.

1. The cabinet will have, permanently and securely mounted inside, a digital flash memory device with a minimum of 4 GB of storage capacity and a standard USB B connector for uploading and downloading electronic versions of record documents and system programming information.

B. The final version of the system database program shall be stored within the cabinet.

1.13 WARRANTY

A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.

B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

1.14 ANNUAL INSPECTION/TESTING AND SERVICE CONTRACT

A. Provide cost to furnish service, inspect, and test all devices of the fire alarm system per the requirement of NFPA for one (1) year, starting one year after the Date of Substantial Completion. Submit written reports of inspection testing per NFPA 72, Chapter 14.

B. Provide an alternate cost for a complete inspection/testing and service/maintenance contract for the fire alarm system for one (1) year two (2) years, starting one year after the Date of Substantial Completion. Submit sample contract terms and conditions for review with shop drawings.

C. The Owner may enter into a contract directly with the vendor after shop drawing submittals. This specification is not a contract between the Owner and the vendor to perform these services.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Johnson Controls - Simplex

2.02 Fire Alarm Pathway Class and Survivability Level

A. Pathway Class:

1. Pathway Class A: Circuits capable of transmitting an alarm signal during an open or a non-simultaneous single ground fault on a circuit conductor wiring system. Wiring of outgoing and return conductors shall be physically separated by a minimum of 50 feet or by a 2-hour rated enclosure.

2. Pathway Class B: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.

3. Pathway Class: SLC for addressable devices with less than 50 devices can be Class A or B, and more than 50 devices shall be Class A.

B. Pathway Survivability Level:

1. Pathway Survivability Level 1: Circuits are protected by an automatic sprinkler system and installed in metal raceways.
2. Shared Pathway Designation Level 2: Provide physical segregation of all life safety and non-life safety data.

2.03 SIGNALING LINE CIRCUIT DEVICES

A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

B. Signal Line Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device type as follows:
      1) W = Weather Proof
      2) WG = Wire guard is required
      3) Candela Ratings:
         a) ## = 15 Candela, 30 Candela; 75 Candela; 110 Candela; 177 Candela
         b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.
   b. Sequence of operation as follows:
      1) D = HVAC Control
      2) DIPS = Dual Interlock Pre-Action System

C. FA-120; Smoke Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device types as follows:
      1) Blank = Photoelectric
      2) CO = Combination Smoke / Carbon Monoxide
      3) COH = Combination Smoke / Carbon Monoxide / Heat
      4) COS = Combination Smoke / Carbon Monoxide / Strobe
      5) H = Combination Smoke / Heat Detectors
2. (BLANK) Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
3. (CO) Combination Smoke / Carbon Monoxide:
   a. Multi-criteria sensor for photoelectrical smoke sensing and carbon monoxide (CO) detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.
   b. The combined photoelectric smoke detection CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.
   c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.

d. The detector shall use only one address on the SLC.

e. CO sensor cartridge element shall be field replaceable.

4. (COH) Combination Smoke / Carbon Monoxide/Heat Detector:

a. Multi-criteria sensor for photoelectrical smoke sensing, heat and carbon monoxide (CO) detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.

b. The combined photoelectric smoke detection / heat / CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.

c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.

d. The detector shall use only one address on the SLC.

e. CO sensor cartridge element shall be field replaceable.

5. (COS) Combination Smoke / Carbon Monoxide/ Strobe Detector:

a. Multi-criteria sensor for photoelectrical smoke sensing, carbon monoxide (CO) detection, and 177 Candela strobe. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.

b. The combined photoelectric smoke detection / heat / CO module shall have separate sensors that adjust the detection profile in response to the input from the sensors.

c. The combined photoelectric smoke detection / CO module shall have selectable modes of operation for OSHA compliant toxic gas sensing, enhanced fire sensing, and nuisance alarm reduction mode.

d. The detector shall use only one address on the SLC.

e. CO sensor cartridge element shall be field replaceable.

6. (H) Combination Smoke / Heat Detector:

a. Multi-criteria sensor for photoelectrical smoke sensing and rate of rise heat detection. Carbon monoxide electrolytic sensing module shall provide toxic gas sensing to UL2034 and UL2075 standards.

b. The detector shall use only one address on the SLC

7. Each smoke detector shall connect directly to an SLC loop, unless listed as stand alone.

8. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.

9. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.

10. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.

11. A test means shall be provided to simulate an alarm condition.

12. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

D. FA-121; Gas Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.

a. Device types as follows:

1) CO = Carbon Monoxide

2. (CO) Analog Carbon Monoxide Type Sensor.

E. FA-122; Duct Smoke Detectors, Sampling Tube Type:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device types as follows:
      1) # = Equipment or system
   b. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
   c. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
   d. Provide a remote alarm LED indicator device (FA-241) or (FA-242) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

F. FA-140; Heat Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
   a. Device types as follows:
      1) Blank = Combination Rate of Rise / Fixed Temp
      2) F = Fixed Temp
      3) RC = Rate Compensated
      4) X = Explosion Proof
2. (BLANK) Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
3. (F) 200°F fixed temperature. Provide a remote addressable monitor module to interface with addressable system as shown on the plans.
4. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
5. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.
6. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.
7. Provide a remote LED indicator device if detector is not visible from a floor-standing position.
8. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.
9. A test means shall be provided to simulate an alarm condition.
10. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

G. FA-160; Monitor Modules:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    a. Device types as follows:
        1) Blank = Refer to Plans
2. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor Option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.
3. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
4. The module shall supply the required power to operate the monitored device(s).
5. The module shall provide address setting means using rotary decimal or DIP switches.

H. FA-161; Addressable Control Module:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation
    a. Device types as follows:
        1) Blank = Refer to Plans
        2) DH = Door Hold Open
        3) PD = Hold Open Override
2. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional child relay(s), as required, rated for the electrical load being controlled (Contractor to match voltage, amps, etc.).
3. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
4. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
5. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

I. FA-280; Isolation Module:

1. Provide fault isolation modules or isolator detector base capable of isolating and removing the fault from Class A or Class X addressable loop data circuits while allowing the remaining data loop to continue operation. Provide a minimum of two isolation modules or bases and between every 15 devices.

2.04 NOTIFICATION APPLIANCE DEVICES

A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

B. Notification Appliance Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    a. Device types as follows:
        1) W = Weather Proof
        2) WG = Wire guard is required

3) Candela Ratings:

a) ## = 15 Candela; 30 Candela; 75 Candela; 110 Candela; 177 Candela

b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.

C. Notification Device(s):

1. Wall Mounted: Red housing with white lettering or pictogram.
2. Ceiling Mounted: Red housing with white lettering or pictogram.

D. FA-200; Visual Alarm Devices:

1. Wall or ceiling mounted, refer to plans.
2. High intensity (Candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.
3. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.
4. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.
5. (W) Weatherproof Visual Notification Device: High intensity strobe, square housing, 75 Candela rating, suitable for wet locations. Provide with weatherproof back box.
   a. Mounting: Semi-flush wall.
   b. Conduit shall not be exposed.

E. FA-210; Audio Horn Alarm Devices:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
2. Wall or ceiling mounted, refer to plans.
3. Sound Rating: 85 dB at 10 feet. Sound levels for alarm signals shall not exceed 120 dBA in the occupied area.
4. Device shall be capable of a high and low dB level setting. Unless noted otherwise, the device shall be set to the high setting at building completion.
5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

F. FA-211; Combination Audio Horn and Visual Alarm Device:

1. Wall or ceiling mounted, refer to plans.
2. Combine audio and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
3. (W) Weatherproof Audio/Visual Notification Device: Electronic horn with high intensity strobe, square housing, 75 Candela, suitable for wet locations. Provide with weatherproof back box.
   a. Mounting: Semi-flush wall.
   b. Conduit shall not be exposed.

2.05 NOTIFICATION APPLIANCE CIRCUIT PANEL (NAC)

A. As shown on the plans or as a Contractor's option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NAC on the shop drawing submittals.

B. Each NAC shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NAC provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.

C. Power for each NAC shall be from a local 120 VAC life safety circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NAC from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Coordinate panel and circuit number with the Architect/Engineer prior to installation.

D. NAC extender panels may be installed only in locations coordinated with the Architect/Engineer.

E. Mounting: Surface.

2.06 CONNECTIONS TO AUXILIARY DEVICES PROVIDED BY OTHERS

A. FA-260; Flow Switch:

1. (FA-260) Connection to flow switch to monitor fire protection flow switch or discharge output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
2. Provide a dedicated monitor switch for each sprinkler flow switch.

B. FA-261; Tamper / Monitor Switch:

1. (FA-261) Connection to monitor switch to monitor fire protection system supervisory switches or output contacts. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC.
2. Tamper switches in the same room or system may be monitored by a single monitor switch when shown grouped on the plans.
3. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
4. Device types as follows:
    a. Blank = Refer to Plans
    b. PIV = Post Indicator Valve
5. (PIV) Post Indicator Valve. Connection to post indicator valve for sprinkler system supervisory notification. Normally open dry contacts for fire alarm interface. Furnished and installed by MC; wired by EC. Provide surge protection device as recommended by the fire alarm system manufacturer on line entering/leaving the facility.

2.07 WIRING

A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with the Electrical Code for power-limited fire alarm signal service.

B. Fire Alarm Cable:

1. Manufacturers:
    a. Comtran Corp.
    b. Helix/HiTemp Cables, Inc.
    c. Rockbestos-Suprenant Cable Corp.
    d. West Penn Wire/CDT.
    e. Radix.

PART 3 - EXECUTION

3.01 SEQUENCES OF FIRE ALARM OPERATION

A. General:

1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.
2. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:
   1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
   2. A local signal in the control panel shall sound.
   3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
   4. History storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
   5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
   6. Transmit the appropriate signal (supervisory, trouble, alarm) to the building automation system via addressable relays tied to contact monitors on the system.
   7. Audible alarms sequence shall match existing sequence

C. Visual Alarms Sequence:
   1. Visual alarm sequence shall match existing sequence.

D. Fire Protection Electric Sprinkler Bell Sequence:
   1. The fire alarm shall utilize an addressable relay to energize the electric sprinkler bell upon activation of the flow switch.

E. HVAC System Sequence:

F. Kitchen Hood Fire Suppression System Sequence:
   1. The fire alarm system shall utilize an addressable relay to de-energize the hood supply fan controller.
   2. The fire alarm system shall utilize an addressable monitor module to monitor the fire suppression system.

G. AHU and Mechanical Fan Shutdown Sequence:
   1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers and mechanical fans. Coordinate other requirements with HVAC installer.
   2. The fire alarm system shall directly shut down the AHU or mechanical fan through the local HVAC control device (i.e., variable frequency drive or motor starter).
   3. Where a facility has more than one AHU or mechanical fan, each shall be shutdown individually based on input from initiation devices in the area served by the unit or designated for each air distribution system.
   4. All AHUs and mechanical fans shall be shutdown simultaneously throughout the building.

3.02 INSTALLATION

A. Install system in accordance with manufacturer's instructions and referenced codes.

B. Devices:
   1. General:
      a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
      b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
      c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.

d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.

2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.

3. Protection of Fire Alarm System:

   a. A smoke detector shall be installed within the vicinity of the main fire alarm panel and every NAC extender panel per NFPA 72. A heat detector may be substituted when a smoke detector is not appropriate for the environment of installation.

4. Duct-type Analog Smoke Detectors:

   a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.

   b. All detectors shall be accessible.

   c. Duct-type detectors shall be installed according to the manufacturer's instructions.

5. In-Duct Analog Smoke Detectors:

   a. In-duct analog smoke detectors shall be installed in the duct where shown on the drawings and details. The devices shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.

   b. All detectors shall be accessible.

6. Addressable Relays and Monitor Modules:

   a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.

   b. All modules shall be mounted in or on a junction box in an accessible location.

   c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.

7. SLC Loop Isolation Modules:

   a. Isolation modules shall be installed to limit the number of addressable devices that are incapacitated by a circuit fault.

   b. Install all Isolation Modules within the fire alarm control panel, unless otherwise indicated on the drawings. Refer to the fire alarm riser diagram for requirements. Refer to the floor plans for areas served by separate isolation modules.

8. Notification Appliance Devices:

   a. Devices shall be located where shown on the drawings.

   b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.

   c. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high, they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.

C. Wiring:

1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
2. Wiring shall be installed in conduit.
3. Wiring shall be installed in conduit from device to above accessible ceilings. Exposed plenum-rated cable (FPLP) shall be used above accessible ceilings supported every 4 feet or run in cable trays (if applicable) maintaining a minimum of 5-inches clearance from all lighting ballasts. Fire alarm cabling shall not be installed in the same bridle rings or cable trays designated for the cabling of other systems.
4. All junction boxes with SLC and NAC circuits shall be identified on cover. Refer to Identification Section 26 0513 for color and identification requirements.
5. Partial evacuation or relocation of occupants is the standard operating procedure for this facility in the event of an alarm. Therefore, all notification appliance circuits (NAC), including circuits serving NAC extender panels and other network communication circuits, must be installed and protected in accordance with the "circuit survivability" requirements described in NFPA 72. Contractor shall maintain the following:
    a. NACs serving separate evacuation signaling zones shall be routed separately such that they are no less than 4 feet apart when run horizontally and 1 foot apart when run vertically. They may come simultaneously only within 10 feet of the control panel.
    b. NACs passing through other evacuation signaling zone(s) shall be installed in conduit and routed through the 2-hour fire-rated chase(s) or enclosure(s) identified on the drawings.
    c. NACs passing through other evacuation signaling zone(s) shall be Electrical Code classified CIC cable (Fire Alarm Circuit Integrity) installed in conduit. Provide CIC cable meeting UL requirements for 2-hour listing.
        1) The CIC cable system shall be installed in a conduit system meeting all requirements of its UL-listed installation system (conduit, boxes, connectors, etc.).
6. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 26 0513.
7. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
    a. Fire alarm temporal audible notification for all audio appliances.
    b. Synchronization of all visual devices where two or more devices are visible from the same location.
    c. Ability to silence audible alarm while maintaining visual device operation.
8. Notification Appliance Circuits shall not span floors.
9. Signal line circuits connecting devices shall not span floors or.
10. Signal line circuits connecting devices shall be provided with an isolation module at each floor separation or as otherwise shown on the drawings.
11. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

D. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.
   1. Power Branch Circuit Conductors: In accordance with Section 26 0553.
   2. Signaling Line Circuit: Overall red jacket with black and red conductors.
   3. DC Power Supply Circuit: Overall red jacket with violet and brown conductors.
   4. Notification Appliance Circuit: Overall red jacket with blue and white conductors.
   5. Door Release Circuit: Gray conductors.
   6. Central Station Trip Circuit: Orange conductors.
   7. Central Station Fire Alarm Loop: Black and white conductors.

E. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.

F. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

3.03 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 0500.

B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.

C. Contractor shall test and adjust the fire alarm system as follows:
   1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than or equal to the greatest of the following:
      a. 70dBA.
      b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
      c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
      d. As specified on the drawings.
   2. Sound level measurement procedure shall meet the following requirements:
      a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
      b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.
      c. All measurements shall be taken after fixed equipment (HVAC units, etc.) producing ambient noise is installed and is in operation.
      d. Final ambient sound measurements shall be taken during occupancy and the units shall be re-adjusted at that time, if necessary.
      e. All sound level measurements shall be taken at a height of 5' above the finished floor level.
      f. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of two (2) rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
      g. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
      h. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.

3.04 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services under provisions of Section 26 0500.

B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.

C. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

D. Include the services to train up to three of the Owner's staff in operation, maintenance, and programming of the fire alarm system at the manufacturer's factory. Airfare and lodging expenses for the Owner's staff will be by the Owner.

E. System Occupancy Adjustments: When requested by Owner within 12 months of date of Substantial Completion, provide on-site system adjustments to suit actual occupied conditions. For this purpose, provide up to two (2) site visits, four (4) hours each visit, outside normal occupancy hours.

3.05 SYSTEM TRAINING

A. System training shall be performed under provisions of Section 26 0500.

B. Minimum on-site training times shall be:

1. System Operators: One (1) day.

END OF SECTION

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SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

1.02 SUMMARY:

A. This section includes the following:
   1. Protection of existing trees.
   2. Removal of Trees and other Vegetation.
   3. Clearing and Grubbing.
   4. Removing above-grade improvements.
   5. Removing below grade improvements.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 31 20 00 Earthwork

1.04 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specifications Section.

B. Schedule indicating proposed sequence of operations for selective demolition work to Owner's Representative for review prior to start of work.

1.05 PROJECT CONDITIONS:

A. Traffic: Conduct site demolition operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction.

B. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary fencing to protect trees and vegetation as instructed on drawings.

C. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

D. Environmental Controls: Comply with governing regulations pertaining to environmental protection.
   1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

E. If unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure both nature and extent of conflict. Submit report to Owner's Representative, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.

F. Salvageable Improvements: Carefully remove items indicated to be salvaged, and store on owner's premises where indicated or directed.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 DEMOLITION:

A. General: Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
   1. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction.

3.02 SITE CLEARING:

A. General: Remove trees, shrubs, grass, and other vegetation, improvements or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated.
   1. Removal includes digging out and off-site disposing of stumps and roots.
   2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.

B. Clearing and Grubbing: Clear sites of trees, shrubs and other vegetation, as indicated on the plans.
   1. Completely remove stumps, roots, and other debris protruding through ground surface.
   2. Use only hand methods for grubbing inside drip line of trees indicated to remain.
   3. Fill depressions caused by clearing and grubbing operations with satisfactory soil materials, unless further excavation of earthwork is indicated.
      a. Compact fill material in accordance with requirements of Section 31 20 00 Earthwork.

C. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated on drawings.

3.03 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove from site debris, rubbish, and other materials resulting from demolition operations. Transport and legally dispose of off-site.
   1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
   2. Burning of removed materials is not permitted on project site.

3.04 CLEAN UP AND REPAIR:

A. General: Upon completion of demolition work, remove tools, equipment, and demolished materials from site. Remove protections:
   1. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start of operations. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

END OF SECTION

SECTION 31 20 00

EARTHWORK

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including General and Supplementary conditions and Division 1 Specification Sections, apply to work specified in this Section.

1.02 DESCRIPTION OF WORK:

A. Extent of Earthwork is indicated on Drawings.

B. Work includes:
1. Stripping, topsoil stockpiling.
2. Excavation.
3. Fill.
4. Compaction.
5. Preparation of subgrade for walls, parking and drives, and steps and walks.
6. Grading.
7. Topsoil placement.
8. Finish grading.
9. Erosion Control
10. Excludes: Over Excavation and Structural Backfill within building pad. Refer to Structural Specifications and Geotechnical Report.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Erosion Control: Section 31 35 00.

B. Site Clearing: Section 31 10 00.

C. Landscape Grading, Section 32 91 19.

1.04 QUALITY ASSURANCE:

A. Codes and Standards:
1. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
2. The entire installation shall fully comply with all local and state laws and ordinances, and with all established codes applicable thereto.

B. Testing and Inspection Service:
1. Cost of field and laboratory testing will be borne by the Owner. Testing by laboratory approved by the Owner and Engineer.
2. Contractor will cooperate with testing laboratory and geotechnical Engineer in coordinating compaction testing, installation and protection of settlement monitoring devices.

1.05 SUBMITTALS:

A. Testing Reports - Excavating: Submit the following reports directly to the Engineer from the testing services, with copies to the Contractor and the Owner.
1 Test reports on borrow material/lab analysis of fill materials.
2. Verification of each footing subgrade (material and unconfined compressive strength).

3. Field density test reports.
4. One optimum moisture-maximum density curve for each type of soil encountered.

Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.

1.06 JOB CONDITIONS:

A. Soil Borings:
1. Soil borings have been made for this site and can be found in Geotechnical Report prepared by TEAM Services (Report No. 1-5118), dated April 12th, 2022.
2. Test borings and other exploratory operations may be made by Contractor at no cost to Owner with Owner approval.

B. Existing Utilities:
1. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
2. Underground utilities shown on the drawings have been taken from existing public records, Owner's records and available as-built drawings and are correct to the best of our knowledge and provided for information only.
3. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities caused by Contractor to the satisfaction of utility owner at no cost to the Project Owner.
4. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.
5. Provide minimum of 48-hour notice to Owner and Engineer and receive written notice to proceed before interrupting any utility.
6. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shut-off of services if lines are active.

C. Protection of Persons and Property:
1. Barricade open excavations occurring as part of this work and post with warning lights.
2. Operate warning lights as recommended by authorities having jurisdiction.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

D. Survey:
1. The topographic survey of the site is provided for informational purposes only. The contractor is responsible for verifying topography of the site prior to construction. No change orders or drawing revisions will be executed or issued for any contractor claims that the survey is wrong. This includes but isn't limited to frost heave or farming activity claims.

PART 2 PRODUCTS

2.01 SOIL MATERIALS/DEFINITIONS:

A. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups CL, ML, CL-ML, GC, GW, GP, GM, ML, SC, SM, SW, and SP.

B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups MH, CH, OL, OH, PT and any bedrock material.

C. Subbase material (granular fill): Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, natural or crushed sand.

D. Fill materials:
1. The fill material type shall be cohesive, soil having a "CL", “CL-ML” soil classification in accordance with the Unified Soil Classification System and shall have a maximum laboratory dry density (100%) of 100 pounds per cubic foot or more as determined by ASTM D698 (Standard Proctor).
2. No organic dark colored soils or plastic and potentially expansive soils, such as clay shale, are considered suitable engineered fill materials. Topsoils should be sorted and stockpiled for landscaping purposes. Topsoil materials can also be used for surcharge fill.
3. When fill material includes rock, the maximum rock size acceptable shall be three inches (3"). No large rocks shall be allowed to nest and all voids must be carefully filled with small stones or earth, properly compacted. No large rocks will be permitted within twelve inches (12") of the finished grade.

E. Topsoil: Secure and stockpile from naturally well drained areas during stripping operations; use satisfactory soil materials free of admixture of subsoil, reasonably free from clay lumps, stone or other debris a greater than 3/4" in diameter.
1. Should also comply with all NPDES and Iowa DNR requirements, if these requirements are more stringent that project specifications.

PART 3 EXECUTION

3.01 EXCAVATION:

A. Excavation is unclassified, and includes excavation to subgrade elevations indicated, regardless of character of materials and obstructions encountered.

B. Unauthorized Excavation:
1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
2. Unauthorized excavation, as well as remedial work resulting from the unauthorized excavation directed by Engineer shall be at Contractor's expense.
3. Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

C. Additional Excavation:
1. When excavation has reached required subgrade elevations, notify Engineer who will make an inspection of conditions. Engineer shall evaluate and advise if bearing material is suitable and shall provide unconfined compressive strength tests.
2. If unsuitable bearing materials are encountered at required elevations, carry excavations deeper and replace excavated material with engineered compacted backfill as directed by engineer in soils/ geotechnical report.
3. Reference Geotechnical/ Soils Report for all possible over excavation.
4. No additional compensation will be provided for grading and pipe installation for the site work unless unsuitable soils are encountered which are not represented in the soils report.
5. It is the intent that if the contractor encounters unsuitable soils within the building envelope (foundation and slab) that the unit prices as seen in the front-end sections 01 22 00 shall apply.

D. Stability of Excavations:
1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction.
a. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

b. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

E. Dewatering:
1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
2. Do not allow water to accumulate in excavations.
3. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations.
4. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
5. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas.
6. Do not use trench excavations as temporary drainage ditches.

F. Material Storage:
1. Stockpile satisfactory excavated materials where directed by Trade Contractor and SWPPP Inspector, until required for backfill or fill.
2. Place, grade and shape stockpiles for proper drainage.
3. Locate and retain soil materials away from edge of excavations.
4. Do not store within drip line of trees indicated to remain.
5. Dispose of excess soil material and waste materials as herein specified.

G. Subgrade Preparation: Paving systems (See Soils Report):
1. Provide a minimum 4” aggregate base for exterior pavements with material meeting the specifications for IDOT granular subbase (Section 4121)
2. Provide a minimum 12” compacted depth subgrade (2-6” lifts) for paving, plus fill as required.
3. Scarify, mix and recompact materials to provide uniform composition at least 12" below top of subgrade for paving for full width of subgrade plus 2'-0" on each side of paving.
4. Construct 12" thick uniform subgrade by excavating top 6" of subgrade, scarifying, mixing, and recompacting next 6" of subgrade and then replacing top 6" of subgrade and recompacting.
5. Proof roll existing soils prior to placing fill to determine location of unsuitable bearing materials. Notify Engineer if unsuitable conditions are encountered for direction. Proof roll truck requirements (axles, wheels and weight) per Iowa DOT specifications.
    a. Perform proof rolling with a truck loaded to the maximum tandem axle gross weight of 40,000 pounds. Operate trucks at less than 10 mph. Make multiple passes for every lane. The subgrade will be considered to be unstable if, under the operation of the loaded truck, the surface shows yielding (soil wave in front of the loaded tires), pumping or rutting of more than ½ inch, measured from the top to the bottom of the rut at the outside edges.
6. Compact as per Paragraph 3.02 Compaction requirements.

H. Topsoil Stripping
1. Strip and stockpile a minimum of the top 6” of soil on all disturbed areas. Additional depth of stripping may be necessary as stated in soils report. Final quantity of topsoil stripped shall be adequate to respreads a minimum of 8” in all green, non-paved areas.

3.02 COMPACTION:

A. General: Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated below.

B. Compaction Requirements: Compact top 12" of subgrade and each layer of backfill or fill material to not less than the following percentages of maximum density:

Construction Type	Standard Proctor ASTM D698 Cohesive Soils
Building, recreation field subgrade walls, roadway, parking lot and critical backfill area beneath same; e.g. trenches	95%
Backfill adjacent to structures not supporting other structures - minor subsidence possible.	95%
Lawn areas. Non-critical areas - moderate subsidence possible.	85-90%
Upper 12 inches of pavement subgrade.	98%
Within 3 feet below footing bearing level.	98%

*Use relative density technique (ASTM D4253 and D4254) where standard proctor technique (ASTM D698) does not result in a definable maximum dry density and optimum moisture content.

C. Moisture Control and Content:
1. When subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by disking, harrowing or pulverizing until moisture content is reduced to a satisfactory value.
4. The fill material shall be compacted at a moisture content typically within a range of optimum moisture content as determined by ASTM D698 (Standard Proctor). Report has varying moisture content ranges depending on plasticity.

3.03 BACKFILL AND FILL:

A. General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
1. In excavations, use satisfactory excavated or borrow material. Site strippings (per soils report) are not to be used as satisfactory excavated material.
2. Under grassed areas, use satisfactory excavated or borrow material.
3. Under walks and pavements, use subbase material or satisfactory scarified and recompacted subgrade or borrow material, or combination of these.
4. Under steps, use subbase material.

5. Under piping and conduit, use subbase material where subbase is indicated under piping or conduit; shape to fit bottom 90 degrees of cylinder.

B. Ground Surface Preparation:
1. Clearing area to be filled: All timber, logs, trees, brush and rubbish shall be removed or otherwise acceptably disposed of.
2. Scarifying area to be filled:
a. All vegetable matter and dark colored organic soil shall be removed from the surface upon which the fill is to be placed (per soils report) and the surface shall be plowed or scarified to a depth of at least 8 inches and until the surface is free from ruts, hummocks or other uneven features which would tend to prevent uniform compaction by the equipment to be used.
b. Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical, the bank shall be stepped or benched. Ground slopes which are flatter than 5 to 1 shall be benched when considered necessary by the Engineer.
3. Compaction area to be filled: After the foundation for the fill has been cleared and plowed or scarified, it shall be disked or bladed until it is uniform and free from large clods, brought to within the specified moisture content range and compacted to not less than ninety-five percent (95%) of maximum dry density in accordance with current ASTM D698 (Standard Proctor).

C. Placement and Compaction:
1. Depth and Mixing of Fill Layers: The selected fill material shall be placed in level, uniform layers which, when compacted, shall have a density conforming to a minimum of ninety-five percent (95%) of maximum dry density in accordance with ASTM D698 (Standard Proctor). Each layer shall be thoroughly blade mixed during the spreading to insure uniformity of material in each layer. Compacted layer thickness will be compatible with the demonstrated compatibility of the compaction equipment being used, with a compacted layer thickness of 6" considered typical.
2. Amount of Compaction: After each layer (lift) has been placed, mixed and spread evenly, it shall be thoroughly compacted to a minimum of ninety-eight percent (98%) of the material's maximum dry density as determined by ASTM D698 (Standard Proctor) for areas within 3 feet below building foundation. Grassed areas or areas not supporting buildings or slabs-on-grade should be compacted to a minimum of ninety-five percent (95%).
3. Compaction of Fill Layer: Compaction equipment shall be of such design to be able to compact the fill to the specified density. Compaction shall be accomplished while the fill material is within the specified moisture content range. Compaction of each layer shall be continuous over its entire area and the compaction equipment shall make sufficient trips to ensure that the required density has been obtained.
4. Compaction of Slopes: Fill slopes shall be compacted. Compacting operations shall be continued until the slopes are stable but not too dense for planting on the slopes. Compacting of the slopes may be done progressively in increments of three to five feet (3' to 5') in fill height or after the fill is brought to its total height.
5. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

3.04 GRADING:

A. General:
1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
2. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.

B. Grading Outside Paving Lines:

1. Grade areas to adjacent to paving lines to drain away from structures and to prevent ponding.
2. Finish surfaces free from irregular surface changes, and as follows:
   a. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations.
   b. Walks: Shape surface of areas under walks to line, grade and cross-section, with finish surface not more than 0.10' above or below required subgrade elevation.

C. Grading Surface of Fill Under Paving & Recreational Fields (coordinate with field specs):
1. Grade smooth and even, free of voids, compacted as specified, and to required elevation.
2. Provide final grades within a tolerance of 1/2" when tested with a 10' straightedge.

D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.05 EMBANKMENTS:

A. General: Prepare site, place and compact excavated materials to required elevation and cross section.

B. Construction:
a. Construct embankment in horizontal layers not more than 8" in loose thickness.
b. Deposit each layer over full width of embankment as separate and distinct operation.
c. After layer is deposited, smooth to uniform depth by means of suitable motor patrol or bulldozer.
d. Compact layer by rolling with tamping type roller until full weight of roller is supported by tamping feet, but with not less than one pass per inch of loose thickness of layer.
e. Roller will be considered to be supported entirely on its tamping feet when feet do not penetrate more than 3" into material being compacted.
f. If soil is wet so that it will not sufficiently compact by one passing of roller per inch of loose thickness, provide one disking per 2" of loose thickness.
   a. Cut and stir full depth of layer.
   b. Allow interval of no longer than two hours between successive diskings, or as directed by Engineer.
   c. After disking is completed compact layer by specified rolling.
g. If soil is dry so that it will not satisfactorily compact by rolling, moisten material before compaction; manipulate material to secure proper distribution of moisture before compaction.
h. Whenever operations are suspended during periods rain is likely to occur, smooth and compact surface to shed water readily.
i. Compact to not less than 95% maximum dry density with moisture content not more than three percentage points above or below optimum; maximum density determined by ASTM D698 (Standard Procter). Different moisture ranges are possible for varying plasticity.

3.06 TOPSOIL SPREADING:

See Section 32 91 19 Landscape Grading.

3.07 FINISH GRADING:

See Section 32 91 19 Landscape Grading.

3.08 MAINTENANCE:

A. Protection of Graded Areas:
1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
2. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

3. Keep public streets clean from soil, soil tracking and debris at all times.

B. Reconditioning Compacted Areas: Where completed graded areas are disturbed by subsequent construction operations, erosion or adverse weather, scarify surface, re-shape and compact to required density prior to further construction.

C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.09 EROSION PROTECTION:

See Section 31 35 00 Erosion Control.

3.10 FIELD QUALITY CONTROL:

A. Quality Control Testing During Construction:
1. Allow testing service to inspect and approve subgrades and fill layers before further construction work is performed.
2. Perform field density tests in accordance with ASTM D2922 (nuclear method) or ASTM D1556 (sand cone method), as applicable.
3. Footing Subgrade: For each strata of soil on which footings will be placed, conduct at least one test every 50 lineal feet to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.
4. Paved Areas and Building Slab Subgrade: Make at least one field density test of subgrade for every 5000 sq. ft. of paved area, but in no case less than 3 tests. In each compacted fill layer, make one field density test for every 5000 sq. ft. of overlaying building slab or paved area, but in no case less than 3 tests.
5. If, in opinion of Engineer, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional expense.

3.11 NATURAL AND ARTIFICIAL DRAINAGE:

A. If necessary during the progress of the work to interrupt the natural drainage of the surface water, Contractor shall provide approved temporary drainage facilities.

B. If necessary to interrupt any field tile drains that might be encountered in this work, the Contractor shall restore or extend drains as necessary. Payment for this work will be on the basis of contract conditions relative to changes in work.

3.12 DISPOSAL OF EXCESS AND WASTE MATERIALS:

A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash and debris from site to an approved location, meeting state and local regulations, for disposal by Contractor.

B. All excess excavation shall be removed from the site unless otherwise stated on plans or directed by the owner.

END OF SECTION

SECTION 31 2005
EARTH MOVING FOR BUILDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Excavating and backfilling for buildings and structures.
2. Drainage course for building concrete slabs-on-grade.
3. Subsurface drainage backfill for walls.

1.03 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

1.04 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
B. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
C. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
D. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

E. Fill: Soil materials used to raise existing grades.
F. Structures: Buildings, footings, foundations, retaining walls, slabs, or other man-made stationary features constructed above or below the ground surface.
G. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

1.05 SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Controlled low-strength material, including design mixture.

B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698.

1.06 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified are in place.

E. Do not commence earth-moving operations until plant-protection measures specified are in place.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Unsatisfactory Soils: Soil Classification Groups OL, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 0 and +4 percent of optimum moisture content for fine-grained soils and at levels satisfactory for compaction to be achieved without the coarse-grained material bulking during placement or pumping when proofrolled at course-grained soils.

C. Satisfactory Soils: Soil shall be free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Satisfactory Soils shall consist of the indicated soil classification groups according to the following locations:

1. Below Building Footings:

a. Low plasticity soil classification group CL with liquid limit less than or equal to 45 and a plasticity index less than or equal to 23.
b. Coarse-grained granular soil classification groups GW, GP, GM, GC, SW, SP, SM, SC.

2. Building Backfill:

a. Coarse-grained granular soil classification groups GW, GP, GM, GC, SW, SP, SM, SC.

3. Below building slabs and below drainage course:

a. Low plasticity soil classification group CL with liquid limit less than or equal to 45 and a plasticity index less than or equal to 23.
b. Coarse-grained granular soil classification groups GW, GP, GM, GC, SW, SP, SM, SC.

4. Below Slab Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and less than 6 percent passing a No. 200 sieve.

2.02 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:

1. Portland Cement: ASTM C 150/C 150M, Type I.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 33/C 33M, 1 1/2 inch nominal maximum aggregate size.
4. Water: ASTM C 94/C 94M.
5. Compressive Strength: 2000 psi.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.03 EXCAVATION, GENERAL

A. Excavation: Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

3.04 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.05 EXCAVATION FOR SLABS ON GRADE

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.06 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.
B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.07 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2000 psi, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.08 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.09 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
B. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 0 and +4 percent of optimum moisture.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 9 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

A. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Cohesive soils: 95% of maximum.
2. Granular soils:
    a. 98 percent of maximum according to ASTM D698.
    b. If the material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction to at least 70% relative density according to ASTM D4253 and D4254.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
    1. Provide a smooth transition between adjacent existing grades and new grades.
    2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
    1. Place drainage course 6 inches or less in compacted thickness in a single layer.
    2. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
    3. Compact each layer of drainage course to required cross sections and thicknesses to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.15 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections
B. Inspections: Refer to Section 01 45 00 “Special Inspections and Tests” for required verifications and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
    1. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 3000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
    2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Relocate surplus satisfactory soil to a location on the Owner's property as directed by the Owner’s Representative.

B. Remove surplus unsatisfactory soil and waste materials, including trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Trench excavation for pipe systems, manholes, intakes and other structures.

B. Trench bedding and foundation stabilization.

C. Pipe and structure placement and backfill.

1.02 DESCRIPTION OF WORK

A. Perform all excavations required to complete the work shown on the plans.

B. Prepare trench excavations and shoring for new work, and install the utility lines, structures, and system components, including bedding and foundation stabilization.

C. Complete specified backfill operation.

D. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Results of Proctor and In-Place Density Tests on backfill.

C. Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store delivered materials and excavated materials in locations that will not interfere with operations and minimize environmental damage.

C. Grade and shape stockpiles for drainage and protect adjacent areas from runoff. Provide erosion control around stockpiles.

D. Remove unsuitable and excess materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by Engineer.
2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
2. Complete other elements of the work that can affect line and grade in advance of other open cut construction unless noted on the plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts, or other environmental or historic items are encountered.

B. Conform to local, state, and federal requirements.

C. Abandoned Utilities: Remove and dispose of abandoned utility lines including gas mains, water mains, sewer mains, telephone conduits, service lines, etc. required to complete the work. Said work shall be incidental to the project unless otherwise specified.

PART 2 - PRODUCTS

2.01 EXCAVATED MATERIALS

A. Unclassified Excavation: Excavation of all materials encountered, except rock and over-excavation.

B. Rock Excavation: Boulders or sedimentary deposits that cannot be removed without continuous use of pneumatic tools or blasting.

C. Over-excavation: Excavation of soil or rock in trenches below the pipe zone.

D. Suitable Excavated Materials for Backfill:
1. Soil, clay, silt, sand, and gravel with moisture content suitable to achieve required compaction. ASTM D 2321, Class II through IVA (see 2.01, E).
2. Fine-grained soils according to ASTM D 2321 Class IVB (inorganic) (see 2.01, E) may be used in the final backfill upon approval of the Engineer.
3. Adjust moisture content of excessively wet, but otherwise acceptable, material by spreading, turning, aerating, and otherwise working material as necessary to achieve required moisture range.
4. Adjust moisture content of excessively dry, but otherwise acceptable material by adding water, then turning, mixing, and otherwise blending the water uniformly throughout the material until the required moisture range is achieved.
5. Lime or fly ash may be added to soils to produce a suitable backfill material. Uniformly mix soil and additive. Determine Standard Proctor maximum density and optimum moisture content of the modified material. Amount of additive applied is subject to Engineer's approval.

E. Non-Manufactured (Excavated) Backfill Materials: (See Sections 2.03 and 2.04 for manufactured backfill)

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½ in. (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	Pl	Uniformity C_u	Curvature C_c
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines	100 %	‹50% of "Course Fraction"	‹5%	Non-Plastic		›4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						‹4	‹1 or ›3
		SW	Well-graded sands and gravelly sands; little or no fines.		›50% of "Coarse Fraction"				›6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						‹6	‹1 or ›3
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines.	100 %	Varies	5% to 12%	Non-Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils, with Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100 %	‹50% of "Coarse Fraction"	12% to 50%		‹4 or ‹"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					‹7 and ›"A" Line		
		SM	Silty sands, sand-silt mixtures.		›50% of "Coarse Fraction"			›4 or ‹"A" Line		
		SC	Clayey sands, sand-clay mixtures.					›7 and ›"A" Line		
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100 %	100%	›50%	‹50	‹4 or ‹"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clay, lean clays.					›7 and ›"A" Line		

IVB (1)	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100 %	100%	›50%	›50	‹"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					›"A" Line		
V	Organic Soils (Unsuitable for backfill)	OL	Organic silts and organic silty clays of low plasticity.	100 %	100%	›50%	‹50	‹4 or ‹"A" Line		
		OH	Organic Clays of Medium to high plasticity, organic silts.				›50	‹"A" Line		
	Highly Organic (Unsuitable for backfill)	PT	Peat and other high organic soils.							

(1) See section 2.01, F, 2 for restrictive use.

F. Unsuitable Material: Remove unsuitable materials from the site, including, but not limited to, the following:
1. Rock with gradation not meeting the stated gradation for stabilization material.
2. Individual stones or concrete chunks larger than 3 inches, and averaging more than one per each cubic foot of soil.
3. Frozen materials.
4. Stumps, logs, branches, and brush.
5. Trash, metal, or construction waste.
6. Soil in clumps or clods larger than 6 inches, and without sufficient fine materials to fill voids during placement.
7. Unsuitable soils, as defined in Section 2010, 2.03, excluding material used as topsoil.
8. Class V Material (ASTM D 2321), as defined in Section 3010, 2.08.
9. Environmentally-contaminated soils.

G. Replacement of Unsuitable Soils:
1. If the excavated material is determined by the Engineer to be unsuitable and cannot be conditioned so that it becomes suitable, furnish all necessary backfill material.
2. Remove and dispose of unsuitable material from the site.

2.02 STABILIZATION (FOUNDATION) MATERIALS

A. Clean 2-1/2 inch crushed stone or crushed portland cement concrete (PCC) material, with the following gradation:

Sieve	Percent Passing
2-1/2"	100
2"	90 to 100
1-1/2"	35 to 70
1"	0 to 15
1/2"	0 to 5

B. Engineer may authorize a change in gradation subject to materials available locally at time of construction. Subject to the Engineer's approval, crushed concrete may be used if it is within plus or minus 5% of the gradation for each size of material.

2.03 CLASS I GRANULAR BEDDING AND BACKFILL MATERIAL (Storm Sewers and Sanitary Sewers)

A. Use gravel or crushed stone for granular bedding, complying with the following gradation:

Sieve	Percent Passing
1-1/2"	100
1"	95 to 100
1/2"	25 to 60
No. 4	0 to 10
No. 8	0 to 5

Note: Engineer may authorize the use of crushed PCC, for pipe sizes up to 12 inches, or a change in gradation subject to materials available locally at time of construction.

B. Compaction: See Section 3.06.

2.04 CLASS II BACKFILL MATERIAL (Storm Sewers, Sanitary Sewers, and Water Mains)

A. Class II material is manufactured and non-manufactured open graded (clean) or dense graded (clean) processed aggregate, clean sand, or coarse-grained natural soils (clean) with little or no fines.

B. Class II material is non-plastic soil less than 1-1/2 inches in size and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GW	Well-graded gravels and gravel-sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	Where hydraulic gradient exists check gradation to minimize migration. Clean groups suitable for use as drainage blanket and underdrain.
GP	Poorly graded gravels and gravel sand mixtures, little or no fines. 50% or more retained on No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	
SW	Well-graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	
SP	Poorly graded sands and gravelly sands, little or no fines. More than 50% passes No. 4 sieve. More than 95% retained on No. 200 sieve. Clean.	

C. Compaction: See Section 3.06.

D. Class II material may be specified in the contract documents by the Engineer between the pipe embedment zone and the top 2 feet of final backfill when the trench is under the pavement.

2.05 CLASS III BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer, and Water Mains)

A. Class III material is natural coarse-grained soils with fines.

B. Class III material follows Section 2.01, G and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
GM	Silty gravels, gravel-sand-silt mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.	Do not use where water condition in trench may cause instability.
GC	Clayey gravels, gravel-sand-clay mixtures. 50% or more retained on No. 4 sieve. More than 50% retained on No. 200 sieve.	
SM	Silty sands, sand-silt mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.	
SC	Clayey sands, sand-clay mixtures. More than 50% passes No. 4 sieve. More than 50% retained on No. 200 sieve.	

C. Compaction: See Section 3.06.

2.06 CLASS IVA BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer, and Water Mains)

A. Class IVA material is natural fine grained inorganic soils.

B. Class IVA material follows Section 2.01, G and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
ML	Inorganic silts, very fine sands, rockflous, silty or clayey fine sands. Liquid limit 50% or less. 50% or more passes No. 200 sieve.	Obtain geotechnical evaluation of proposed material. May not be suitable under deep fills, surface applied wheel loads, and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause instability.
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. Liquid limit 50% or less. 50% or more passes No. 200 sieve.	

C. Compaction: See Section 3010, 3.06.

D. Suitable only in dry trench conditions.

2.07 CLASS IVB BACKFILL MATERIAL (Storm Sewer, Sanitary Sewer and Water Mains)

A. Class IVB material is natural fine-grained inorganic (high elastic silts and plastic clays - fat clay) with a liquid limit greater than 50%.

B. Class IVB material follows Section 3010, 2.01 and consists of the following:

SOIL TYPE	DESCRIPTION OF MATERIAL CLASSIFICATION	REMARKS SECTION
MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.	Not to be used in pipe embedment zone.
CH	Inorganic clays of high plasticity, fat clays. Liquid limit greater than 50%. 50% or more passes No. 200 sieve.	

C. Compaction: See Section 3.06.

D. When approved by the Engineer, Class IVB material may be used as final trench backfill in a dry trench.

E. Do not use in the pipe embedment zone.

2.08 CLASS V BACKFILL MATERIAL (Topsoil)

A. Class V Material is natural highly organic soils with a liquid limit greater than 50%. See Section 2.01.

B. Use Class V Material only as topsoil outside of the pavement, unless otherwise specified or allowed by the Engineer.

C. Do not use Class V Material in the pipe embedment zone.

2.09 BEDDING AND BACKFILL MATERIALS FOR PIPE CULVERTS

A. Bedding:
1. Use minimum Type C embedment.
2. Install water stop or curtain wall at culvert inlet, as specified in the contract documents.

B. Backfill Material:
1. Use all suitable material excavated for pipe culvert work, as specified in Section 2.01, for backfill material.
2. Dry suitable material that has excessive moisture prior to placement.
3. Remove unsuitable material, as specified in Section 2.01, from the project site.

2.10 BEDDING AND BACKFILL MATERIALS FOR SUBDRAINS

A. Drainable Bedding and Backfill Materials Include:
1. Porous backfill material.
2. Pea gravel.
3. Use as shown on the plans or on the detailed drawings.

B. Porous Backfill Material:
1. Crushed stone or gravel with the following gradation:

Sieve	Percent Passing
3/4"	100
1/2"	95 to 100
3/8"	50 to 100
No. 4	10 to 50
No. 8	0 to 8

Iowa DOT Gradation No. 29.

C. Coarse Aggregate: Use Stabilization Materials, per Section 3010.

D. Pea Gravel: Use commercially available pea gravel.

E. Impervious Bedding: Use least permeable on-site materials.

F. Engineering Fabric: Use Iowa DOT 4196.

2.11 SPECIAL PIPE EMBEDMENT MATERIAL

A. Concrete Supports: Where specified in the contract documents, construct concrete support systems.

B. Concrete Bedding, Arch, or Encasement:
1. Concrete: commercial, 4,000 psi compressive strength.
2. Unreinforced, unless otherwise shown on the plans.
3. Minimum concrete thickness: 6 inches or as shown on the plans.

C. Flowable Mortar:
1. Approximate quantities per cubic yard:
   a. Cement 100 pounds
   b. Fly ash 300 pounds
   c. Fine aggregate 2,600 pounds
   d. Water, approximate 70 gallons
2. Compressive strength at 28 days; 100 psi to 200 psi.

D. Controlled Low Strength Material (CLSM):
1. Approximate quantities per cubic yard:
   a. Cement 50 pounds
   b. Fly ash 250 pounds
   c. Fine aggregate 2910 pounds
   d. Water, approximate 60 gallons
2. Compressive strength at 28 days 50 psi.

PART 3 - EXECUTION

3.01 PREPARATION

A. When natural soils for Class II, III, and IV backfill material is required as specified in Figure 3010.1, provide written certification from a testing laboratory that the material meets the class specified if so requested by the Engineer.

B. Locate, mark, and protect existing utilities and facilities in the work area.

C. Provide access to utility service locations, such as valves, manholes, and utility poles.

D. Identify owners of utilities on or near the site, and notify them of operations to occur.

E. Protect existing facilities and landscaping features, or replace as shown on the plans.

F. Protect bench marks, control points and land survey monumentation, or replace at Contractor's expense.

3.02 TRENCH EXCAVATION

A. Notify the Engineer prior to the start of excavation activities.

B. Remove and stockpile a minimum of 6” of topsoil for subsequent reuse.

C. Place excavated material away from trench. Grade spoil piles to drain. Do not allow spoil piles to obstruct drainage.

D. Remove rock, rubbish, boulders, debris, and other unsuitable materials at least 6 inches below, and on each side of the pipe. Restore grade using soil suitable for backfill.

E. Correct unauthorized excavation at no cost to Owner, using bedding or stabilization materials.

F. Provide protective fences and barricades around open excavations, appropriate to the surrounding area.

G. Provide weight tickets for stabilization material to the Engineer at the time of delivery.

H. Provide safety fence around open excavations.

I. Trench Excavation for Sanitary Sewers, Storm Sewers, Water Mains, and Pipe Culverts:
   1. Maximum and minimum pipe trench width: Min.=Pipe Dia.+1.5’; Max.=1.25*Pipe Dia. or 54”, whichever is greater.
   2. Flat trench bottom, conduit bearing directly on trench bottom (not applicable for rock excavation) for water main pipe only with bell hole shaping:
      a. Shape trench bottom to support pipe around 1/4 of perimeter for the full length of the pipe barrel.
      b. Provide bell holes.
   3. Trench bottom, conduit supported by bedding material:
      a. Excavate trench as shown on the detailed drawings.
      b. Install bedding material to support the full length of the pipe barrel.
   4. Trench depth:
      a. Flow Line plus Pipe Dia/8, or 4” min.
   5. Conform all trench operations to current OSHA regulations.

J. Structure Excavation:
   1. For concrete structures and parts of structures without footings, 18 inches outside the horizontal projection of the structure.
   2. For concrete structures with footings, 18 inches outside the footings.
   3. For anchor rods, 12 inches on each side of the rod.
   4. For buried anchors, the face of the buried anchor on one side and 24 inches outside the buried anchor on the other face.

3.03 ROCK OR UNSTABLE SOILS IN TRENCH BOTTOM

A. Notify the Engineer prior to over-excavation.

B. Engineer will determine the need for trench bottom stabilization prior to installation of pipes and structures.

C. See Figure 3010.1 for over-excavation of rock and wet or soft foundations.

D. Provide weight tickets for the stabilization material to the Engineer at the time of delivery.

3.04 SHEETING, SHORING, AND BRACING

A. Conform sheeting and bracing of all excavations to the latest state and federal regulations governing safety of workers in the construction industry.

B. Leave in place all temporary sheeting below 2 feet over top of pipe unless sheeting removal plan is approved by Engineer. Conform all trench operations to current OSHA regulations.

C. Move trench boxes carefully to avoid excavated wall displacement or damage.

D. When necessary or required, install adequate sheeting and bracing to prevent ground movement that may cause damage or settlement to adjacent structures, pipelines, and utilities.

E. Any damage due to settlement because of failure to use sheeting or because of inadequate bracing, or through negligence or fault of the Contractor in any other manner, shall be repaired at the Contractor's expense.

F. For sides of trenches in unsuitable, loose, or soft material, shore, sheet, brace, slope, or otherwise support by means of sufficient strength to protect employees working within them.

G. Where excavations are made with vertical sides that require supporting, use sufficient strength for sheeting and bracing to sustain the sides of the excavations and to prevent movement that could in any way injure the work or adjacent structures, or diminish the working space sufficiently to delay the work.

H. Select sheeting and bracing material of sufficient dimensions and strength to adequately support the sides of trenches and excavations, which will not split when driving and will be free of imperfections that may impair its strength or durability.

I. Drive sheeting to true alignment and ensure contact of adjacent pieces.

J. In wet excavation, use grooved sheeting to prevent passage of soil. Fill any voids between sheeting and face of excavation with suitable material.

K. Do not remove sheeting and bracing before the completion of the work, unless otherwise directed by the Engineer.

L. For sheeting left in place, cut off 18 inches for clearance below the bottom of the pavement in streets/highways and 18 inches below the original ground surface, unless otherwise required by the contract documents or the Engineer. Leave in place all temporary sheeting below 2 feet over top of pipe, unless a sheeting removal plan is approved by Engineer.

3.05 DEWATERING

A. Do all work in dry conditions; do not install pipes on excessively wet soil.

B. Perform the dewatering operation according to the dewatering plan submitted to the Engineer. Dewatering operations may be modified from the plan for actual field conditions, with approval of the Engineer.

C. Adequate dewatering is the Contractor's responsibility unless otherwise stated in the contract documents.

D. Install dewatering system appropriate for the soil conditions.

E. Maintain water levels sufficiently below the bottom of trench excavation, (typically 2 feet) to prevent upward seepage.

F. Provide for handling water encountered during construction:
1. Prevent surface water from flowing into excavation. Remove water as it accumulates.
2. Do not use sanitary sewers for disposal of trench water. Discharging water into storm sewers requires Engineer's approval.
3. Do not discharge water onto adjacent property.
4. Maintain and control water discharge as necessary to prevent a safety hazard for vehicular and pedestrian traffic.
5. Direct water discharge away from electrical facilities or equipment and intersections.
6. Use noise and fume reducing dewatering equipment to minimize disturbance.
7. Provide at least two operating pumps for each trench opened in wet ground, and at the same time have one pump in reserve.

G. Place backfill in trenches prior to stopping dewatering operations.

H. Protect trench water discharge points from erosion.

I. Operate dewatering systems to prevent damage to adjoining structures and facilities.

J. Monitor adjoining structures and facilities during dewatering operations. Cease dewatering operations and notify the Engineer if damage is observed.

3.06 PIPE INSTALLATION

A. Pipe Bedding:
1. Shape pipe bed to evenly support pipe at the proper line and grade, with full contact under the bottom of the pipe.
2. Install pipe and system components.
3. Place bedding simultaneously on both sides of the pipe. Correct any pipe displacements before proceeding.
4. Place bedding in lifts no greater than 6 inches thick and consolidate.
5. Concrete encasement: Install where shown on the plans.
6. If required in the contract documents or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other bedding material types.
7. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.

B. Haunch Support:
1. Place granular haunch material in lifts no greater than 6 inches thick and consolidate by slicing with a shovel or using other approved techniques.
2. If required in the contract documents, or if approved by the Engineer, concrete, flowable mortar, or controlled low strength material may be used instead of other haunch material types. Secure pipe against displacement or flotation prior to placing flowable mortar, controlled low strength material, or concrete encasement.

C. Primary and Secondary Backfill (Pipe Cover):
1. Place pipe cover material in 6-inch lifts and compact to densities required according to class of material.
2. If required in the contract documents or if approved by the Engineer, flowable mortar or controlled low strength material may be used in lieu of other cover material types. Secure pipe against displacement or flotation prior to placing flowable mortar or concrete encasement.
3. Special pipe support: If required, provide special pipe support as shown on the plans.

D. Final Trench Backfill:

1. Place backfill in the trench immediately after recording locations of connections and appurtenances or at Engineer's direction.
2. Place backfill adjacent to structures immediately after concrete has reached design strength and connecting work has been completed.
3. Allow no more than 100 feet of trench to be open overnight or when work is not in progress except as provided on the plans.
4. Place suitable excavated backfill:
   a. Carefully place backfill over top of pipe and around structures.
   b. Compact as required.
5. Compaction:
   a. Within street right-of-way and under pavement, compact each lift to at least 95% of maximum Standard Proctor Density, otherwise compact to at least 90%.
   b. In areas more than 3 feet below pavement structure, place backfill in lifts no thicker than 8 inches.
   c. In areas less than 3 feet below pavement structure, place backfill in lifts no thicker than 6 inches. Terminate backfill at 8 inches below finish grade in areas to remain unpaved, and to subgrade elevation in areas to be paved. Place 8 inches of topsoil in unpaved areas.
   d. When crossing under levees, railroads, and State or Federal highways, comply with the compaction requirements of these jurisdictions, if more stringent than these requirements.
   e. For Vitrified Clay Pipe (VCP), keep all heavy compaction equipment 5 feet above the top of the pipe. In the area less than 5 feet, use hand held compactors. Do not allow the compactor to come in contact with the pipe.
6. Moisture Range: Obtain required compaction within a soil moisture range of minus two percent to plus four percent (-2% to +4%) of optimum moisture content as determined by ASTM D698 (Standard Proctor).
7. Dispose of surplus and unsuitable materials unless otherwise directed by owner.
8. Hydraulic compaction is not allowed unless authorized by the Engineer.

3.07 PIPE INSTALLATION IN CONSTRUCTED EMBANKMENTS

A. Install all pipes in trenches according to Section 3.06. When allowed by the contract documents, pipes may be constructed in embankments as follows:

B. Placing Backfill for Pipes:
1. Thoroughly tamp backfill under and around the pipe and in layers not to exceed 8 inches for the full length and width of the pipe.
2. Place backfill and thoroughly tamp around and over the pipe for its full length.
3. Extend the completed embankment on both sides of the pipe from the original ground line to at least 1 foot above the top of the pipe with a slope as shown in the contract documents. Construct the embankment over the pipe with a width no less than the outside diameter of the pipe and centered over the pipe. If necessary to accommodate construction traffic, increase the height of fill to the nominal diameter of the pipe or 3 feet, whichever is greater.
4. When pipe are laid wholly or partly in a trench, granular backfill material may be required for backfill. Compact the remainder of the fill to at least 1 foot above the top of the pipe with slopes as outlined above.
5. If the trench has been cut wide enough to permit use of a roller, after the pipe is bedded, thoroughly tamp the backfill material under and alongside the pipe with a mechanical tamper to the mid-height elevation of the pipe.
6. The contract documents may require placement of pipe with moisture control. When not required, place roadway pipe after construction of an embankment by methods that will produce results equivalent to those required for construction of the embankment, except that moisture determinations will be waived for placing backfill completed within 48 hours after excavation.
7. In addition to the normal backfill material requirements, when directed by the Engineer, build such approach fills to provide a roadway 10 feet in width over the pipe with grades no steeper than 10%.

3.08 STRUCTURE BEDDING

A. Bedding for Structures Bearing on Undisturbed Soils:
   1. Shape the bottom to accurate grade and size.
   2. Remove loose material, large clods, stones, and foreign materials.
   3. In unstable soils or rock conditions, see Section 3.03 for stabilization requirements.

B. Bedding for Structures Bearing on Bedding Material:
   1. Over excavate to minimum of 8 inches or as specified in the contract documents.
   2. Place bedding material for structures according to the contract documents. A

3.09 STRUCTURE BACKFILL

A. Removal of Forms and Falsework: See Section 6010, 3.06.

B. Placement of Backfill: Place backfill after structure concrete has reached at least 80% of the design strength and connecting work has been completed, unless otherwise specified. Determine strengths under comparable conditions. If strength is not determined, place backfill after 14 days.

C. Backfill Against Walls and Around Structures:
   1. Where backfill is required on both sides of a concrete wall and around all sides of monolithic structures, proceed with filling operations simultaneously on all sides of walls and structures so the fill is kept at approximately the same elevation at all times. Consider concrete box, arch, and circular culvert monolithic structures.
   2. Compact the 3 feet closest to all walls or wing faces by pneumatic or hand tampers only.

D. Placing Backfill with Excavated Material:
   Unless otherwise specified, see Section 3.06, D for suitable excavated materials for backfill.

3.10 OPEN CUT CASING PIPE INSTALLATION

A. Casing Pipe: Install casing pipe according to Section 3.01 to 3.07, as appropriate.

3.11 TRACER SYSTEM

A. Tracer wire shall be provided on <u>all</u> site utilities, including but not limited to:

   1. Telecommunication/copper.
   2. Empty conduits.
   3. Storm
   4. Sanitary.
   5. Gas.
   6. Water.
   7. Exceptions:
      a Straight storm runs with daylight each end do not require tracer wire).
      b Underground electrical lines do not require tracer wire.

B. Tracer wire: Solid, AWG #12, blue insulated, direct bury, Type TWHN. Install in trench attached directly to, parallel with, and centered above or below the utility.

C. Underground splices: Use Scotchcast splicing kits, 3M Company or approved equal.

D. Engineer shall provide specific details for tracer wire termination at each condition. Avoid receptacle boxes on posts in lawn areas (Install receptacle boxes on face of building or in flush ground boxes).

E. Test tracer wire for continuity after installation (see comment under “Specifications - Project Close-Out” above); All tracer wire which fails continuity testing shall be repaired or replaced as required until passing continuity testing. Provide Owner 48-hour notice of this activity.

F. In addition to tracer wire, Contractor shall install underground pipe markers: bright colored continuously printed plastic ribbon tape, 6” wide by 3.5 mils thick, manufactured for direct burial, with aluminum foil core for location by non-ferric metal detectors and bold lettering identifying buried item. Install 8” to 10” below grade directly above buried utilities.

3.12 FIELD QUALITY CONTROL

A. References:
1. ASTM C 136; Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D 698; Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Moisture Using 5.5-pound (4.54 kg) Rammer and 12-inch (305 mm) Drop. (Standard Proctor Method)
3. ASTM D 1556; Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D 2216; Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
5. ASTM D 2922 and D 3017; Test Methods for Density of Soil and Soil-Aggregate in Place and Water Content of Soil and Rock by Nuclear Methods (Shallow Depth).
6. ASTM D 4253 and D 4254, Test Methods for Maximum Index Density of Soils using a Vibratory Table and Minimum Index Density of Soils and Calculation of Relative Density.

B. Compaction Testing: Compaction testing of backfill, cooperate and coordinate with an independent testing laboratory selected by the Owner. Cost of initial compaction testing will be paid for by the Owner. Cost of retesting of failed test areas shall be paid for by the Contractor. Refer to Section 014000, 1.5, Test and Inspection Services, and this Section 3.12, G. below for additional requirements.

C. Schedule Testing: Notify the Owner’s Representative and the independent testing laboratory when work is prepared for testing.

D. Soil Testing:

1. Cohesive soils: Determine moisture-density relationships by ASTM D 698 (Standard Proctor). Perform at least one test for each type of cohesive soil used.

2. Cohesive soils: Determine in-place density and moisture content using ASTM D 1556 (sand-cone method) and D 2216 or ASTM D 2922 and D 3017 (nuclear).

3. Non-cohesive soils: Determine maximum and minimum index density and calculate relative density using ASTM D 4253 and D 4254 (cohesionless soils).

4. Gradation: Test according to ASTM C 136.

E. Testing Frequency and Locations**:** Perform testing of the final trench backfill, beginning at a depth of 2 feet above the top of the pipe, as follows:
1. Contractor provided:
   a. Make one test per each 2 vertical feet of consolidated fill at each street crossing.
   b. Make one test per each 2 vertical feet of consolidated fill for each 200 horizontal feet of trench.
   c. Additional testing may be required by Engineer if non-compliance or a change in conditions occur.
   d. Coordinate the timing of testing with the Engineer.
   e. The Engineer will determine the location of testing.
   f. If necessary, excavate to the depth and size as required by the Engineer to allow compaction tests. Place backfill and recompact.
2. Owner provided:

a. Coordinate the timing of testing with the Engineer.
b. The Engineer will determine the location of testing.
c. Test frequency will not exceed one test per each 2 vertical feet of consolidated fill for each 200 horizontal feet of trench.

F. Test Failure: Rework, recompact, and retest as necessary until specific compaction is achieved in all areas of the trench.

G. Retesting: In event of failed tests, rework the failed area and retest. Costs of such retesting shall be paid by the Contractor, at no additional cost to the owner.

END OF SECTION

SECTION 31 35 00

EROSION AND SEDIMENT CONTROL

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. NPDES General Permit No. 2

B. Stormwater Pollution Prevention Plan (SWPPP)

C. Erosion Control Measures

D. Velocity and Flow Control Measures

E. Sediment Control Measures

F. Application/Installation of Measures

G. Removal/Replacement of Measures

1.02 DESCRIPTION OF WORK

A. Furnish all materials; install, construct, maintain, and remove specified erosion control devices; at locations specified in the contract documents, or where specified by the Engineer, Owner and City.

B. Complete the required construction work on this project, while minimizing soil erosion and controlling water pollution. Maintain these features as specified, from initial construction stages to final completion of the project.

1.03 SUBMITTALS

Comply with Division 1 -General Provisions and Covenants, as well as the following:

Upon request, provide copies of all records and documentation related to compliance with the Iowa DNR NPDES Permit.

1.04 SUBSTITUTIONS

Comply with Division 1 -General Provisions and Covenants.

1.05 DELIVERY, STORAGE, AND HANDLING

Comply with Division 1 -General Provisions and Covenants.

1.06 SCHEDULING AND CONFLICTS

Comply with Division 1 -General Provisions and Covenants, as well as the following:

A. Implement erosion and sediment control measures at the appropriate time(s).

B. Coordinate construction to minimize damage to erosion and sediment control devices.

1.07 SPECIAL REQUIREMENTS

A. Permit:

1. When applicable, comply with the requirements of the Iowa Department of Natural Resources, *NPDES (National Pollutant Discharge Elimination System) General Permit No. 2 for Stormwater Discharge Associated with Industrial Activity for Construction Activities*, and the Stormwater Pollution Prevention Plan.

2. For projects covered under the Iowa DNR General Permit No. 2, sign on as a co-permittee with the owner and any other contractors or subcontractors.

3. When applicable, comply with the local jurisdiction's permitting requirements.

B. Protection of Property: Prevent accumulation of soil, sediment, or debris from project site onto adjoining public or private property. Remove any accumulation of soil or debris immediately, and take remedial actions for prevention.

Protect Existing Facilities At The Site Against Damage Including The Following:

1. The Contractor shall take precautions to ensure that equipment, vehicles, and construction operations do not disturb or damage existing grades, walls, drives, pavement, utilities, plants, lawns, and other facilities.

2. Verify locations and depths of all underground utilities prior to excavation and report any conflicts with new work to the Engineer.

3. Any damage to existing trees or shrubs branches and root systems to remain and be protected shall be repaired and/or pruned by an experienced arborist.

4. Repair, replace, and/or return to original condition any damaged item, without additional compensation.

C. Permit Compliance: When applicable, conduct all operations in compliance with the Iowa DNR NPDES General Permit No. 2. Labor, equipment, or materials not included as a bid item, but necessary to prevent stormwater contamination from construction related sources, are considered incidental. Incidental work related to compliance with the permit may include, but is not limited to: hazardous materials protection, fuel containment, waste disposal, and providing employee sanitary facilities.

D. Project Staging: Replacing erosion and sediment control practices that are damaged or removed by the contractor in a manner that is inconsistent with the current project staging or SWPPP is the Contractor's responsibility and will be at the Contractor's expense.

PART 2 -PRODUCTS

2.01 COMPOST BLANKETS

Comply with Section 32 92 19, Seeding, 2.07, C for compost material requirements for compost blankets.

2.02 COMPOST BLANKET AND FILTER BERM TACKIFIER

A. Use a biodegradable, organic binding agent or polyacrylamide that can be mixed with, or injected into, compost or filter material as it is placed, which is not detrimental to the establishment of vegetation.

B. Use in filter berms or compost blankets when specified in the contract documents.

C. Apply at the rate recommended by the manufacturer.

2.03 FILTER MATERIAL

Material for use in filter socks, filter berms, and other areas, as specified in the contract documents.

A. Use material derived from wood, bark, or other, non-toxic vegetative feedstocks.

B. Use material with no visible admixture of refuse or other physical contaminants, nor any material toxic to plant growth.

C. Use material meeting the following particle sizes:

Sieve Size	Percent Passing1
2”	100
1”	90-100
3/8”	0-30

[1]The target flow rate of in-place material is 10 gal/min/lf. The Engineer may approve use of alternate materials meeting the target flow rate.

2.04 FILTER SOCK

A. For slope and sediment control applications, use a continuous, tubular, knitted, mesh netting with 3/8 inch openings, constructed of 5 mil thickness, photodegradable HDPE.

B. For inlet protection, use a continuous, tubular, knitted, mesh netting with 3/8 inch openings, constructed of 500 denier polypropylene.

C. Use 1 inch by 2 inch (minimum) hardwood stakes or stakes of equivalent strength.

2.05 TEMPORARY ROLLED EROSION CONTROL PRODUCTS (RECP)

Use temporary rolled erosion control products that are classified and have material properties according to the Erosion Control Technology Council’s (ECTC) guidelines as follows:

A. Material Classification:

1. RECP Type 1 (Ultra Short-term): Functional longevity of 3 months or less and classified as follows:

a. RECP Type 1.A: Mulch control net, consisting of a photodegradable synthetic mesh or woven biodegradable natural fiber netting.

b. RECP Type 1.B: Netless rolled erosion control blankets, consisting of natural and/or polymer fibers,

mechanically interlocked and/or chemically adhered together to form a RECP.

c. RECP Type 1.C: Single-net erosion control blankets and open weave textiles, consisting of processed degradable natural and/or polymer fibers, mechanically bound together by a single rapidly-degrading, synthetic or natural fiber netting, or an open weave textile of processed rapidly-degrading natural or polymer yarns or twines woven into a continuous matrix.

d. RECP Type 1.D: Double-net erosion control blankets, consisting of processed degradable natural and/or polymer fibers, mechanically bound together between two rapidly-degrading, synthetic or natural fiber nettings.

2. RECP Type 2 (Short-term): Functional longevity between 3 and 12 months and classified as follows:

a. RECP Type 2.A: Mulch control net, consisting of a photodegradable synthetic mesh or woven biodegradable natural fiber netting.

b. RECP Type 2.B: Netless rolled erosion control blankets, consisting of natural and/or polymer fibers, mechanically interlocked and/or chemically adhered together to form a RECP.

c. RECP Type 2.C: Single-net erosion control blankets and open weave textiles, consisting of an erosion control blanket composed of processed degradable natural or polymer fibers, mechanically bound together by a single degradable synthetic or natural fiber netting to form a continuous matrix, or an open weave textile composed of processed degradable natural or polymer yarns or twines woven into a continuous matrix.

d. RECP Type 2.D: Double-net erosion control blanket, consisting of processed degradable natural and/or polymer fibers, mechanically bound together between two degradable synthetic or natural fiber nettings.

3. RECP Type 3 (Extended Term): Functional longevity between 12 and 24 months and classified as follows:

a. RECP Type 3.A: Mulch control nets, consisting of a slow-degrading synthetic mesh or woven natural fiber netting.

b. RECP Type 3.B: Erosion control blankets and open weave textiles, consisting of processed slow-degrading natural or polymer fibers, mechanically bound together between two slow-degrading synthetic or natural fiber nettings to form a continuous matrix, or an open weave textile composed of processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix.

4. RECP Type 4 (Long Term): Functional longevity of 36 months and classified as follows: Erosion control blankets and open weave textiles, consisting of processed slow-degrading natural or polymer fibers, mechanically bound together between two slow degrading synthetic or natural fiber nettings to form a continuous matrix, or an open weave textile composed of processed slow-degrading natural or polymer yarns or twines woven into a continuous matrix.

B. Properties and Performance:

1. Testing performed according to the ECTC's Testing Procedures for Rolled Erosion Control Products. Verify manufacturer's test results by independent testing.
2. Material properties meeting the Erosion Control Technology Council's (ECTC) Standard Specifications for Rolled Erosion Control Products as follows:

*Product tested according to ECTC Test Method No. 2 and meeting the ECTC Standard Specifications for "C" factor.

C. RECP Anchors: Stakes or staples as recommended by manufacturer, with a minimum length of 6 inches.

2.06 WATTLES

A. Netting: Open weave, degradable netting. Nominal diameter of 9 inches, or as specified.

B. Fill Material: Straw, wood excelsior, coir, or other natural materials approved by the Engineer.

C. Stakes: 1 inch by 1 inch (minimum) wooden stakes, or stakes of equivalent strength.

2.07 CHECK DAMS

A. Synthetic Permeable Check Dam (HDPE):

1. Ditch Berm:
a. Installed height of 9 to10 inches.
b. Manufactured check dam constructed from sheets of perforated, UV-stabilized High-Density Polyethylene (HDPE).

c.

Classification	Slope Application	Channel Application	Min. Tensile Strength
	Max. Grade*	Permissible Shear Stress	
RECP Type 1.A	5:1 (H:V)	0.25 lb/ft2	5 lb/ft
RECP Type 1.B	4:1 (H:V)	0.50 lb/ft2	5 lb/ft
RECP Type 1.C	3:1 (H:V)	1.50 lb/ft2	50 lb/ft
RECP Type 1.D	2:1 (H:V)	1.75 lb/ft2	75 lb/ft
RECP Type 2.A	5:1 (H:V)	0.25 lb/ft2	5 lb/ft
RECP Type 2.B	4:1 (H:V)	0.50 lb/ft2	5 lb/ft
RECP Type 2.C	3:1 (H:V)	1.50 lb/ft2	50 lb/ft
RECP Type 2.D	2:1 (H:V)	1.75 lb/ft2	75 lb/ft
RECP Type 3.A	5:1 (H:V)	0.25 lb/ft2	25 lb/ft
RECP Type 3.B	1.5:1 (H:V)	2.00 lb/ft2	100 lb/ft
RECP Type 4	1:1 (H:V)	2.25 lb/ft2	125 lb/ft

Perforations of 30 to 40% open area.

2. RECP for Permeable Check Dam (when specified): RECP Type 4, 4 feet wide.

3. Anchors: As recommended by the manufacturer.

B. Triangular Foam Check Dam: Triangular-shaped device with a height of 8 to 10 inches and a base of 16 to 20 inches.

1. Inner Support Material: Urethane foam.

2. Outer Cover: Woven geotextile material shaped to fit around the inner support material, extending 2 to 3 feet beyond the bottom edge of the triangular-shaped inner support.

3. Length: 7 feet.

C. Rock Check Dam:

1. Aggregate: Erosion stone complying with Iowa DOT Article 4130.04.

2. Engineering Fabric: Comply with Section 2.20.

2.08 LEVEL SPREADERS

A. Provide 2 inch by 8-inch (minimum) pressure-treated timber of the length specified.

B. Use timbers that are relatively straight and have a minimum length of 5 feet each.

2.09 RIP RAP

A. Class A Revetment: Comply with Iowa DOT Section 4130.

B. Class B Revetment: Comply with Iowa DOT Section 4130.

C. Class D and E Revetment: Comply with Iowa DOT Section 4130.

D. Erosion Stone: Comply with Iowa DOT Section 4130.

2.10 TEMPORARY PIPE SLOPE DRAINS

A. PVC, HDPE, and metal pipes as specified in Section 33 40 00, Storm Sewer, 2.01.

B. HDPE, Type C (corrugated interior).

C. All pipes listed are allowed for use within the right-of-way.

2.11 SEDIMENT BASIN OUTLET STRUCTURES

A. Base: Class C concrete unless otherwise specified in the contract documents.

B. Riser: CMP complying with Section 33 40 00, Storm Sewer; diameter as specified in the contract documents.

C. Dewatering Device:

1. Drill holes in the riser of the number, diameter, and at the elevation specified in the contract documents.

2. 1/4 inch by 1/4 inch or 1/2 inch by 1/2 inch wire mesh for hardware cloth.

D. Barrel: CMP complying with Section 33 40 00, Storm Sewer; diameter as specified in the contract documents.

E. Anti-Vortex Device: CMP complying with Section 33 40 00, Storm Sewer; diameter and riser diameter as specified in the contract documents.

F. Anti-Seep Collar: Corrugated metal sheet of same material and gage as barrel section.

Size according to plans.

2.12 SEDIMENT TRAPS

A. Erosion Stone: Comply with Section 2.09

B. Engineering Fabric: Comply with Section 2.20.

2.13 SILT FENCE

A. Fabric: Comply with Iowa DOT Article 4196.01.

B. Posts: 4 foot minimum steel (T-section) weighing at least 1.25 pounds per foot, exclusive of anchor plate. Painted posts are not required.

C. Fastener: Wire or plastic ties with a minimum tensile strength of 50 pounds.

2.14 STABILIZED CONSTRUCTION ENTRANCE

A. Entrance Stone: Comply with Iowa DOT Section 4122, Gradation 13, Macadam crushed stone.

B. Subgrade Stabilization Material: Use woven, UV-stabilized geotextile with a minimum tensile strength of 135 lb/ft.

2.15 DUST CONTROL

A. Water: Use potable water or water from a source approved by the engineer.

B. Calcium Chloride: Comply with Iowa DOT Article 4194.01.

C. (Not Used)

D. Soapstock (Soybean Oil):

1. Use a commercially-available, undiluted, soybean oil soapstock emulsion.

2. Comply with manufacturer's recommendations for storage, transportation, temperature, and application equipment requirements.

2.16 EROSION CONTROL MULCH

A. Conventional Mulch:

1. Use dry cereal straw (oats, wheat, barley, or rye) or native grass straw.

2. Use material that is free of noxious weeds, seed-bearing stalks, or roots, and will be inspected and approved by the Engineer prior to use.

3. Other materials, subject to the approval of the Engineer, may be used.

B. Hydromulch:

1. Wood Cellulose Mulch:

a. Use material that is a natural or cooked cellulose fiber processed from whole wood chips, or a combination of up to 50% of cellulose fiber produced from whole wood chips, recycled fiber from sawdust, or recycled paper (by volume).

b. Product contains a colloidal polysaccharide tackifier adhered to the fiber to prevent separation during shipment and avoid chemical co-agglomeration during mixing.
c. Form a homogeneous slurry of material, tackifier, and water.

d. Use a slurry that can be applied with standard hydraulic mulching equipment.

e. Dye the slurry green to facilitate visual metering during application.

f. Do not use materials that have growth or germination-inhibiting factors or any toxic effect on plant or animal life when combined with seed or fertilizer.

2. Bonded Fiber Matrix (BFM):

a. Produced from long-strand wood fibers, held together by organic tackifiers and bonding agents that, when dry, become insoluble and non-dispersible.

b. Upon curing 24 to 48 hours, form a continuous, 100% coverage, flexible, absorbent, erosion-resistant blanket that encourages seed germination.

c. Manufactured to be applied hydraulically.

d. Physical Properties:
1) Fibers: Virgin wood, greater than 88% of total volume.
2) Organic Material: Greater than 96% of total volume.
3) Tackifier: 8-10%.
4) pH: 4.8 minimum.
5) Moisture Content: 12% +/- 3%.
6) Water-holding Capacity: 1.2 gal/lb.

e. Dyed green to facilitate visual metering.

3. Mechanically Bonded Fiber Matrix (MBFM): See Section 32 92 19, Seeding.

a. Produced from long-strand wood fibers and crimped, interlocking synthetic fibers.\

b. Within two hours of application, form a continuous, 100% coverage, flexible, absorbent, porous, erosion-resistant blanket that encourages seed germination.

c. Manufactured to be applied hydraulically.

d. Physical Properties:
1) Wood Fibers: 73% minimum.
2) Tackifier: 10% +/- 1%.
3) Crimped, Interlocking Synthetic Fibers: 5% +/- 1%.
4) Moisture Content: 12% +/- 3%.
5) Water holding capacity: 1.2 gal/lb.
6) Minimum pH: 4.8.

e. Dyed green to facilitate visual metering.

2.17 TURF REINFORCEMENT MATS (TRM)

A. Material Classification:

1. TRM Type 1: Use a TRM that is constructed of a web of mechanically or melt-bonded polymer netting, monofilaments, or fibers that are entangled to form a strong and dimensionally stable mat. Bonding methods include polymer welding, thermal or polymer fusion, or the placement of synthetic fibers between two high-strength, biaxially-oriented nets, mechanically bound by parallel stitching with polyolefin thread. Products may contain a degradable component.

2. TRM Type 2 and 3: Use a TRM that is constructed of a web of mechanically or melt-bonded polymer netting, monofilaments, or fibers that are entangled or woven to form a strong and dimensionally stable mat. Non-woven bonding methods include polymer welding, thermal or polymer fusion, or the placement of fibers between two high-strength, biaxially oriented nets, mechanically bound by parallel stitching with polyolefin thread. Use only components that are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

3. TRM Type 4: Use a high performance/survivability TRM that is composed of monofilament yarns woven into a resilient uniform configuration. Use a mat that has a matrix that exhibits very high interlock and reinforcement capacities with both soil and root systems and demonstrate a high tensile modulus. TRMs manufactured from discontinuous or loosely held together by stitched or glued, netting, or composites are not allowed in this category. Use only components that are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. Use this category when field conditions exist with high loading and/or high survivability requirements.

B. Properties and Performance: Meet the minimum material and performance requirements contained in the following table:

Property1		**Test Method**	**Type 1**	**Type 2**	**Type 3**	**Type 4**
Material	Thickness	ASTM D 6525	0.25 in	0.25 in	0.25 in	0.25 in
	Tensile Strength2	ASTM D 6818	125 lb/ft	240 lb/ft	750 lb/ft	3,000 lb/ft
	UV Resistance3	ASTM D 4355	80% @ 500 hrs	80% @ 1,000 hrs	80% @ 1,000 hrs	90% @ 3,000 hrs
Performan ce	Maximum Shear Stress4 (Channel Applications)	ASTM D 6460	7 lb/ft2	10 lb/ft2	12 lb/ft2	15 lb/ft2
	Maximum Slope Gradient (Slope Applications)	N/A	1:1 (H:V) or flatter	1:1 (H:V) or flatter	1:1 (H:V) or greater	1:1 (H:V) or greater

1 For TRMs containing degradable components, all values must be obtained on the non-degradable portion of the matting.
2 Minimum Average Roll Values, machine direction only.
3 Tensile strength of structural components retained after UV exposure.
4 Minimum shear stress that fully-vegetated TRM can sustain without physical damage or excess erosion (0.5 in soil loss)
during a 30 minute flow event in large scale testing. Acceptable large scale testing protocol includes ASTM D

6460 or independent testing conducted by the Texas Transportation Institute, Colorado State University, Utah State University, or other approved testing facility. Bench scale testing is not acceptable.

2.18 INLET PROTECTION

A. Drop-in Intake Protection:

1. Use a manufactured device that is inserted into the intake and is capable of trapping or filtering sediment from runoff prior to entering the storm sewer.

2. All components must be contained entirely below the surface of the intake grate.

3. Incorporate means of emergency outflow to prevent flooding if plugged with sediment.

B. Surface-applied Intake Protection:

1. Use devices or filter socks, placed around or over the intake, that are capable of trapping or filtering sediment from runoff prior to entering the storm sewer.

2. Do not allow the device to completely block or plug the intake, preventing inflow.

2.19 FLOW TRANSITION MATS

A. UV-stabilized HDPE plastic sheet with openings for vegetation growth and energy dissipation.

B. Use a nominal sheet size of 4 feet by 4 feet by 1/2 inch.

C. Use duckbill style anchors, as specified by the mat manufacturer.

2.20 ENGINEERING FABRIC

Comply with Iowa DOT Article 4196.01, B (Embankment Erosion Control) and Iowa DOT Materials I.M. 496.01, Appendix G.

PART 3 -EXECUTION
3.01 SWPPP PREPARATION

A. Prepare a SWPPP according to the requirements of the Iowa DNR NPDES General Permit No. 2.

B. Ensure that controls utilized in the SWPPP conform to the type and quantity of erosion and sediment controls specified in the contract documents. MidAmerican Energy Environmental Services will provide a Notice of Intent template that must be used

C. Submit the completed SWPPP to the Engineer and MidAmerican Energy Environmental Services for review and approval prior to filing the Notice of Intent.

D. Upon approval of the Engineer, file public notices, as required by the NPDES General Permit No. 2.

E. File the Notice of Intent and fee, as required by the NPDES General Permit No. 2 and any local ordinance requirements.

3.02 SWPPP MANAGEMENT

Coordinate and carry out all requirements of Iowa DNR NPDES General Permit No. 2 and any local ordinance requirements, including:

A. Update the SWPPP according to the requirements of the NPDES General Permit No. 2.

B. Revise the SWPPP and implement changes, as necessary, to prevent sediment or hazardous materials from being transported off the site.

C. Submit all SWPPP revisions to the Engineer for review and approval.

D. MidAmerican Energy will hire an approved Inspector to perform and maintain records of weekly erosion and sediment control site inspections, unless otherwise specified in the contract documents.

E. Maintain records of transfer of responsibility under the NPDES General Permit No. 2.

F. Retain all records on-site, or as required by the NPDES General Permit No. 2.

G. After final stabilization, MidAmerican Energy Environmental Services will file a Notice of Discontinuation, according to the NPDES General Permit No. 2 and at the recommendation of the Inspector and local authority.

H. Provide all records and documentation to the Engineer upon completion of the project. MidAmerican Energy will retain a copy of all records for the period required under the Permit.

I. Continue to perform the work required under this item throughout the duration of the project, and until final stabilization is achieved and a Notice of Discontinuation is filed.

3.03 EROSION AND SEDIMENT CONTROL INSPECTION

A. MidAmerican Energy will hire an approved Inspector to perform inspections according to and at frequency required by the Iowa DNR NPDES General Permit No. 2.

B. Schedule necessary maintenance or improvements for items that are included in the contract documents.

C. Notify the Engineer immediately of situations requiring attention beyond that provided for in the contract documents.

D. Provide copies of the inspection reports to the Engineer.

3.04 EQUIPMENT

Comply with Iowa DOT Article 2601.03.

3.05 COMPOST BLANKETS

A. Loosen the ground surface to a minimum depth of 1 inch.

B. Evenly spread compost, as specified in the contract documents, or as directed by the Engineer.

C. Divert concentrated flows away from the slope.

D. Do not operate heavy equipment over the compost blanket after placement, or throughout the required period of protection.

E. Inspect the ground under the blanket at regular intervals for signs of erosion.

3.06 FILTER BERMS

A. Install filter berm along the contour as specified in the contract documents, or as directed by the Engineer.

B. Turn the ends of the filter berm uphill to prevent runoff from flowing around the end of the berm.

C. When a vegetated berm is specified, apply seed to the surface of the berm.

D. Replace the berm when sediment accumulation reaches one-half of the height of the berm.

3.07 FILTER SOCKS

A. Installation:

1. Pneumatically fill mesh filter sock of size and length specified in the contract documents, or as directed by the Engineer. Alternative methods of filling the sock may be allowed upon approval of the Engineer.

2. Fill socks with filter material.

3. Place the filter sock along the contour as specified in the contract documents, or as directed by the Engineer.

4. Place additional filter material or soil from the site, on the upstream side of the sock, in the seam between the tube and the ground.

5. Construct a “J-hook” at each end of a continuous run of filter sock, by turning the end of the sock uphill, as necessary to prevent runoff from flowing around the ends when water behind the sock ponds up to a level even with the top of the sock.

6. Drive stakes into the ground at a maximum spacing of 10 feet, and as required to secure the sock and prevent movement.

7. Repair or replace non-functioning filter socks that allow water to flow under the sock, are torn, or are otherwise damaged, due to inadequate installation.

8. Remove filter material from damaged socks that are located along streambanks, around intakes, in ditches, or in other locations where the material may be carried to surface waters.

B. Removal: When specified in the contract documents, or as directed by the Engineer; remove the filter sock upon completion of the project, and after final stabilization is achieved; or as indicated in the SWPPP, if applicable.

1. Upon completion of the project, completely remove socks and filter material that are located along streambanks, around intakes, in ditches, or in other locations where the filter material may be carried to surface waters if the sock degrades and/or tears.

2. Slice the sock longitudinally. Remove and dispose of the filter sock material and stakes.

3. Spread the filter material and accumulated sediment to match finished grade and to ensure proper drainage.

4. If the site has been brought to finished grade and prepared for permanent seeding, spread and incorporate the filter material into the surface by tilling, or as required to break up any large particles and provide a finished surface suitable for permanent seeding.

C. Replacement:

1. When accumulated sediment reaches a level one-half the height of the sock, or when the sock becomes

clogged with sediment and no longer allows runoff to flow through, remove the sock as described above, and replace according to the installation instructions above.

2. At the Engineer's option, the existing filter sock and accumulated sediment may be left in place, and a new filter sock installed up-slope from the existing filter sock.

3.08 TEMPORARY ROLLED EROSION CONTROL PRODUCTS (RECP)

Install temporary RECPs according to the manufacturer's published installation recommendations, subject to the following minimum requirements:

A. Slope Application:

1. Grade and smooth surface. Remove all rocks, clods, vegetation, or other obstructions that will prevent direct contact between the RECP and the soil surface.

2. When specified, prepare seedbed and place seed and fertilizer according to Section 32 92 19, Seeding prior to placing RECP.

3. Install anchor trench at top of slope. Seed and fertilize trench after backfill and compaction, if seeding is specified.

4. Unroll the RECP down or horizontally across the slope.

5. Place consecutive blankets down the slope end-over-end, shingle style.

6. Overlap ends of consecutive rolls a minimum of 3 inches, and install anchors at a maximum spacing of 18 inches along all overlaps.

7. Overlap edges of adjacent rolls a minimum of 2 inches.

8. Install anchors at edge seams between rows.

B. Channel/Ditch Application:

1. When specified, prepare seedbed and place seed and fertilizer according to Section 32 92 19, Seeding, prior to placing RECP.

2. Place end of first roll in the anchor slot at the center of the upstream channel and secure with anchors.

3. Position adjacent rolls in the anchor slot, overlapping adjacent rolls a minimum of 3 inches.

4. Place backfill material in anchor slot and compact. Unroll RECP over compacted slot and secure with anchors.

5. Unroll RECP downstream. Maintain a minimum 3 inch overlap between adjacent rolls. Secure edge lap with anchors.

6. Install intermittent staple check slots every 30 feet.

7. Construct end lap at end of roll and beginning of new roll. Overlap roll ends with upstream RECP on top.

8. Excavate longitudinal trench along both sides of the channel at the outside edges of installation. Place outer edges of RECP into longitudinal slot. Install anchors, place backfill material, and compact.

9. Terminate installation at downstream end with staple check.

10. Install anchors in a regular pattern over entire area covered according to manufacturer's published recommendations (minimum three anchors per square yard).

3.09 WATTLES

A. Installation:

1. Construct a shallow trench, 2 to 4 inches deep, matching the width and contour of the wattle.

2. Install wattle along contour of slope.

3. Turn ends of wattle uphill to prevent water from flowing around ends.

4. Place and compact excavated soil against the wattle, on the uphill side.

5. Drive stakes through the center of the wattle, into the ground at a maximum spacing of 4 feet along the length of the wattle, and as needed to secure the wattle and prevent movement.

6. Abut ends of adjacent wattles tightly. Wrap joint with a 36 inch wide section of silt fence and secure with stakes.

B. Removal: When specified in the contract documents, or as directed by the Engineer, remove the wattle upon completion of the project, and after final stabilization is achieved; or as indicated in the SWPPP, if applicable.

1. Completely remove the wattle netting, filler material, and stakes.

2. Spread the accumulated sediment to match finished grade and to ensure proper drainage.

3. When allowed by the Engineer, the wattle netting may be sliced open and the filler material spread out over the ground. Removal of netting and stakes and spreading of sediment is still required.

C. Replacement:

1. When accumulated sediment reaches a level one-half the height of the wattle, or when the wattle becomes clogged with sediment and no longer allows runoff to flow through, remove the wattle as described above, and replace according to the installation instructions above.

2. At the Engineer's option, the existing wattle and accumulated sediment may be left in place, and a new wattle installed up-slope from the existing wattle.

3.10 CHECK DAMS

A. Synthetic Permeable Check Dam (HDPE):

1. Install according to the manufacturer's recommendations.

2. When specified, provide an RECP under the check dam, installed according to the manufacturer's recommendations.

B. Triangular Foam Check Dam: Install according to the manufacturer's recommendations.

C. Rock Check Dam: Construct according to plans.

D. Removal: When specified in the contract documents, or as directed by the Engineer, remove check

dams upon completion of the project, and after final stabilization is achieved; or as indicated in the SWPPP, if applicable.

1. Remove the check dam and dispose of materials, or salvage to the contractor.

2. Remove the accumulated sediment or spread to match finished grade; ensure proper drainage.

3. Stabilize the area disturbed by removal operations.

3.11 TEMPORARY EARTH DIVERSION STRUCTURES

A. Ensure positive drainage along the diversion toward the outlet area.

B. Adequately compact fill to prevent failures or seepage.

C. Outlet the diversion to undisturbed and/or stabilized areas only.

D. Stabilize the surface of the earth diversion with temporary erosion control seeding, as specified in Section 32 92 19, Seeding.

3.12 LEVEL SPREADERS

A. Butt multiple timbers together, as necessary to provide the required length.

B. Ensure the spreader is installed level in all directions. Adjust as necessary during construction to maintain spreader in a level condition.

C. Excavate a depression behind the spreader to the depth specified in the contract documents. The depression may be over-excavated up to 1 foot to provide an area for sediment accumulation.

D. Grade as required to prevent flow around the ends of spreader.

E. Remove the accumulated sediment from the depression when the depth is reduced below that specified in the contract documents.

3.13 RIP RAP

Install the quantity of rip rap (revetment stone or erosion stone) as specified in the contract documents.

3.14 TEMPORARY PIPE SLOPE DRAINS

A. Place slope drain on undisturbed soil or well compacted fill.

B. Carefully compact cohesive soils around inlet ends of the drain in 6 inch lifts.

C. Discharge slope drain to a stable outlet or to a sediment retention device.

3.15 SEDIMENT BASIN OUTLET STRUCTURES

A. Concrete Base: Construct the concrete base and anchor riser section, as shown on plans.

B. Dewatering Device:

1. Drill holes in the riser section. The number, diameter, and configuration will be specified in the contract documents.

2. Wrap the perforated section of the riser pipe with metal hardware cloth.

C. Anti-vortex Device: If required by the contract documents, firmly attach the cylinder to the top of the riser by welding or other means. Comply with plan details for fabrication.

3.16 ANTI-SEEP COLLAR

A. General: Place backfill material and compact over excavation areas to a minimum of 95% Standard Proctor Density per Section 31 23 33 Trenching and Backfilling.

B. Concrete Collar:

1. Place collars a minimum of 2 feet from pipe joints.

2. Provide Class C concrete per Section 33 49 00 Storm Drainage Structures.

C. CMP Collar:

1. Provide collar of same gage as the pipe barrel on which it is used.

2. Paint or tag unassembled collars to identify matching pairs.

3. Furnish each collar with two 1/2 inch diameter rods with tank lugs for connecting collars to pipe.

4. Install collar with corrugations vertical.

5. Seal the tap between the two half sections and between the pipe and connecting band with a bituminous jointing compound at the time of installation.

3.17 SEDIMENT TRAPS

Construct the storage area to the size and elevations specified in the contract documents.

3.18 SILT FENCES

A. Installation:

1. Install material along the contour of the ground, as specified in the contract documents, or as directed by the Engineer.

2. Install silt fence with a mechanical soil slicing machine that creates a slit in the ground while simultaneously installing the fabric. The trenching method may be used when situations will not allow soil slicing, as determined by the Engineer.

3. Construct a “J-hook” at each end of a continuous run of silt fence, by turning the end of the silt fence uphill, as necessary to prevent runoff from flowing around ends when water behind the fence ponds to a level even with the top of the fence.

4. Insert 12 inches of fabric to a minimum depth of 6 inches (fabric may be folded below the ground line).

5. Compact installation by driving along each side of the silt fence, or by other means, as necessary to adequately secure the fabric in the ground, to prevent pullout and water flow under the fence.

6. Drive steel posts into the ground alongside the silt fence, to a minimum depth of 20 inches, unless otherwise specified by the Engineer. Space posts at 5 feet on-center maximum, or as required to adequately support silt fence.

B. Maintenance: Repair or replace non-functioning silt fence that allows water to flow under the fence, is torn, or is otherwise damaged, due to inadequate installation, at no additional cost to the Contracting

Authority.

C. Removal:

1. Remove the silt fence upon final stabilization of the project area, or according to the staging indicated in the SWPPP.

2. Remove and dispose of silt fence and posts.

3. Remove sediment or spread to match finished grade; ensure proper drainage.

4. Stabilize the area disturbed by removal operations.

D. Replacement:

1. When accumulated sediment reaches a level one-half the height of the fence, remove the silt fence as described above, and replace according to the installation instructions above.

2. At the Engineer's option, the existing silt fence and accumulated sediment may be left in place, and a new silt fence installed up-slope from the existing silt fence.

3. When allowed by the Engineer, the existing silt fence may be left in place and the accumulated sediment removed to the original ground line and within 6 inches of the silt fence. Carefully inspect the existing silt fence for structural integrity and signs of undermining. Make any necessary repairs.

3.19 STABILIZED CONSTRUCTION ENTRANCE

A. Install a stabilized construction entrance at all locations where construction traffic leaving the site presents the potential for sediment track-out.

B. Remove vegetation and excavate soft soils from entrance area. Thoroughly compact subgrade prior to placing stone.

C. Install culvert under entrance if necessary to maintain drainage.

D. Grade entrance to prevent runoff from flowing onto street. Direct all runoff from entrance to a sediment retention device.

E. When specified, install subgrade stabilization fabric prior to placing crushed stone.

F. Install layer of crushed stone to the thickness (6 inches minimum) and dimensions specified in the contract documents.

G. Remove the accumulated sediment and install new stone, as required to prevent track-out.

3.20 DUST CONTROL

A. Water: Apply frequent light watering to ground surface, as required to control dust.

B. Calcium Chloride: Apply according to Iowa DOT Section 2314.

C. (Not Used)

D. Soapstock (Soybean Oil):

1. Loosen the top 1 to 2 inches of the roadway surface.

2. Apply undiluted soapstock at a rate of 0.70 gal/yd^2.

3. Allow product to penetrate through the loosened material.

4. Tight-blade road surface.

3.21 EROSION CONTROL MULCHING

A. Conventional Mulching:

1. Use conventional mulching when the surface cannot be stabilized by seeding, due to season or ground conditions.

2. Uniformly distribute mulch over the required areas, at a rate of 2 tons/acre for dry cereal straw, or 2.5 tons/acre for prairie hay.

3. Work the mulch into the soil with a mulch tucker, designed to anchor the mulch into the soil, by means of dull blades or disks.

B. Hydromulching:

1. Place mulch and tackifier (if applicable) in equipment specifically manufactured for hydraulic mulching.

2. Mix materials with fresh, potable water using a combination of re-circulation through the equipment's pump and mechanical agitation to form a homogeneous slurry.

3. If necessary, dampen any dry, dusty soil as required to prevent balling of the material during application.

4. Apply hydromulch in multiple layers from opposing directions, where possible.

5. Apply the slurry evenly over all specified areas, at the minimum component material rates specified:
   a. Wood Cellulose Mulch: 1) Mulch: 2,600 lb/acre dry weight. 2) Tackifier: 50 lb/acre.
   b. Bonded Fiber Matrix: 3,600 lb/acre dry weight.
   c. Mechanically Bonded Fiber Matrix: 3,600 lb/acre dry weight.

6. Retain and count empty bags of mulch to ensure final application rate.

3.22 TURF REINFORCEMENT MATS

Install according to the manufacturer's published installation literature for the product specified and application (slope or channel).

3.23 SURFACE ROUGHENING

A. Directional Tracking:

1. Do not use on slopes steeper than 3:1.

2. Operate tracked equipment up and down exposed slope to create ridges perpendicular to the slope.

3. Continue operation until the entire surface has been tracked.

B. Grooving/Furrowing:

1. May be used on all slopes.

2. Use rippers, disks, harrows, chisel plows, or other equipment capable of operating on the slope and creating grooves a maximum of 15 inches apart and 3 inches deep.

3. Operate equipment along the contour of the slope to create grooves that are perpendicular to the slope.

4. Perform over all exposed slopes as specified.

3.24 INLET PROTECTION

A. Install inlet protection devices according to the manufacturer's recommendations.

B. Remove the accumulated sediment, as required to maintain the inlet protection device in working order. Remove any accumulated sediment from streets open to traffic if it encroaches into the traveled roadway.

3.25 FLOW TRANSITION MATS

Install according to the manufacturer's published recommendations.

3.26 TEMPORARY EROSION CONTROL SEEDING

Comply with Section 32 92 19, Seeding.

END OF SECTION

SECTION 32 11 23

AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base.

1.02 RELATED SECTIONS

A. Section 31 20 00 - Earthwork.

B. Section 32 13 13 - Concrete Paving.

1.03 REFERENCES

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; American Association of State Highway and Transportation Officials; 2001 (2004).

B. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2000a.

C. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2000.

D. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2002.

E. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 1994(R 2001).

F. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2000.

G. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

H. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.04 SUBMITTALS

A. Materials Sources: Submit name of imported materials source and provide material certifications.

1.05 PROJECT CONDITIONS

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate Base Course: Conforming to State of Iowa Highway Department standard 4121 unless otherwise stated in the plans.

2.02 SOURCE QUALITY CONTROL

A. Testing of samples for compliance will be provided before delivery to site.

B. If tests indicate materials do not meet specified requirements, change material and retest at Contractor's

expense.

C. Provide materials of each type from same source throughout the work.

D. Upon delivery of 1,000 tons of aggregate to the site prior to spreading of rock, owner's geotechnical engineer will test gradation of aggregate and verify it meets specification. Contractor must notify owner's geotechnical engineer with a minimum 4 working day notice.

E. During rock placement, gradation testing compliance will be required every 200 tons of aggregate material delivered to site. Contractor required to coordinate testing with geotechnical engineer. If aggregate does not pass gradation, contractor responsible for removal and replacement of material as determined by geotechnical engineer and owner.

F. Contractor responsible for any subsequent gradation testing that is required for aggregate that does not pass gradation tests.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

A. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

A. Under Paving:
   1. Place aggregate base course to a total compacted thickness as specified on site plan.
   2. Compact to 95 percent of maximum dry density.

B. Level and contour surfaces to elevations and gradients indicated.

C. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

D. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.

B. Variation From Design Elevation: Within 1/2 inch (12 mm).

3.05 FIELD QUALITY CONTROL

A. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556.

B. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").

C. If tests indicate work does not meet specified requirements, remove work, replace and retest at Contractor's expense.

D. Contractor shall coordinate work with testing laboratory before proceeding with each phase or stage of work.

3.06 CLEAN-UP

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including Bidding Requirements, General and Supplementary Conditions and Division I Specification Sections, apply to work specified in this Section.

B. Comply with ACI 316 "Recommended Practice for Construction of Concrete Pavements and Concrete Bases" for all work.

1.02 WORK INCLUDED:

Provide all labor, materials, equipment and supervision required to construct concrete pavement, driveways, parking lots, curbs, walks, steps, edging, etc. including:

A. Concrete.

B. Curing and sealing.

C. Contraction and expansion joints and fillers.

D. Vapor barrier.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Earthwork: Section 31 20 00.
B. Joint Sealant: Section 32 13 73.

1.04 QUALITY ASSURANCE:

A. Cost of field and laboratory testing will be borne by the Owner. Testing by laboratory approved by the Owner. Lab reports shall be simultaneously forwarded to the Owner, Contractor and Engineer.

B. Testing:
   1. Slump to be checked in accordance with ASTM C143. One test minimum per hour.

   2. Air content measured in accordance with ASTM C231, or C173. One test minimum daily.

   3. Strength tests:
      a. Take one set of three (3) cylinders for each one hundred fifty (150) cubic yards or part thereof. Minimum one set of three (3) cylinders per each day's pour.
      b. Each cylinder shall be plainly marked showing cylinder designation (1A, 1B, 1C).
      c. Job cure each cylinder three (3) days.
      d. After three (3) days, send cylinders A and B to the laboratory approved by the Engineer for testing at ages seven (7) days and twenty-eight (28) days. Cylinder C to remain at the job as a "spare" cured under same conditions as concrete in the area from which it was taken.
      e. The date and location of each sample shall be marked on the Contractor’s job set of plans.

f. Load and core tests shall be required only if cylinder tests indicate concrete does not meet Specifications. Such tests, if deemed advisable by the Engineer, shall be arranged and paid for by the Contractor.

4. Pavement Smoothness: Evaluate pavement smoothness for all PCC pavement surfaces. Straightedge: The Engineer will check PCC pavement surfaces with a 10 foot straightedge placed parallel to the centerline. Areas showing high spots of more than 1/4 of an inch in 10 feet will be marked. Complete surface corrections according to the procedures in Iowa DOT Section 2316 to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straightedge. Surface corrections will be completed at the direction of the Engineer with no additional cost to the Owner.

5. Pavement Thickness:

a. At locations determined by the Engineer, cut samples from the pavement by drilling with a core bit that will provide samples with a 4 inch outside diameter. Restore the surface by tamping low slump concrete into the hole, finishing, and texturing. The Engineer will witness the core drilling, identify, and take possession of the cores. The Engineer will determine the core locations, measure the cores, and determine the thickness index according to Iowa DOT Materials I.M. 346 and 347, except as modified as follows:

i. For regular or irregular shaped areas, use a lot size of 1,000 square yards. Include remnants less than 500 square yards in the last lot and remnants greater than 500 square yards in a separate lot. Take a minimum of three cores per project.

ii. For any core with a deficiency greater than 0.15 inch, take two additional cores in that pavement lot and use the average of the three cores.

b. Coring of pavement or other work for thickness determination may be waived by mutual agreement for sections of the same design thickness less than 2,500 square yards.

c. Based on the thickness index determined by the Engineer, the pavement payment will be as shown below:

Pay Factor for PCC Pavement Thickness

Thickness Index Range (in.)	Percent Payment
0 to -0.15	100
-0.16 to -0.25	95
-0.26 to -0.50	85
Greater than -0.51	As determined by the Engineer

d. If the thickness index deficiency is greater than 0.51, the Engineer will study the extent and severity of the deficiency of the pavement areas. The Engineer will require one of the following:

i. Removal and replacement of the deficient areas with pavement complying with the contract documents at no additional cost to the Owner.

ii. Completion of an agreement that provides a combination of an extended guarantee period and payment penalty and allows the deficient pavement to be left in place.

1.05 SUBMITTALS:

A. Certification of concrete C-4 design mix with Class 3 durability aggregate by a testing laboratory. Submit prior to placement.

B. Submit plan for construction sequence and schedule prior to commencing construction.

C. Submit jointing plan 10 days prior to paving.

1.06 CODES, PERMITS AND FEES:

A. The entire installation shall fully comply with all local and state laws and ordinances, and with all established codes applicable thereto.

1.07 SITE DISTURBANCES:

A. Take precautions to ensure that equipment and vehicles do not disturb or damage existing site grading, walks, drives, utilities, plants, etc.

B. Verify locations and depths of all underground utilities prior to excavation.

C. Repair and/or return to original condition any damage caused by Contractor's negligence at no cost to Owner.

D. Provide temporary barricades and warning lights as required for protection of project work and public safety.

1.08 PAVEMENT PROTECTION

A. Weather Conditions: Do not place concrete when stormy or inclement weather or temperature prevents good workmanship. Temperature restrictions and protection requirements may be modified by the Engineer under unusual conditions. Pavement damaged by inclement weather shall be removed and replaced.

1. Cold Weather:

a. Paving: Do not place aggregates containing frozen lumps, and do not place concrete on a frozen subgrade or subbase. Take all necessary actions to prevent the pavement from freezing.

1) Concrete mixing and placement may be started, if weather conditions are favorable, when the air temperature is at least 34ºF and rising. At the time of placement, concrete must have a temperature of at least 40ºF.

2) Stop mixing and placing when the air temperature is 38ºF or less and falling or if the temperature stops rising and does not reach 38ºF.

b. Protection: Prior to applying protection, cure all concrete pavement and curb/gutters, including exposed edges of the pavement and curb. In addition, protect concrete less than 36 hours old as follows

Night Temperature Forecast	Type of Protection[1]
35°F to 32°F	One layer of burlap for concrete.
31°F to 25°F	Two layers of burlap or one layer of plastic on one layer of burlap.
Below 25°F	Four layers of burlap between layers of 4 mil (100 µm) plastic or equivalent commercial insulating material approved by the Engineer.

[1] The protection shall remain until one of the following conditions is met:
a. The pavement is 5 calendar days old.
b. Opening strength is attained.
c. Forecasted low temperatures exceed 35°F for the next 48 hours.
d. Forecasted high temperatures exceed 55°F for the next 24 hours and subgrade temperatures are above 40°F.

1) Shut down paving operations in time to comply with protection requirements outlined above. During cold weather, allow more time for finishing and protection. Perform all finishing and covering operations prior to darkness. Temperature restrictions and protection requirements may be modified by the Engineer.
2) Equivalent commercial insulating material approved by the Engineer may be used. This material must be waterproof and have a minimum R value of 1.0. If initial set has not yet occurred, place a layer of burlap on top of concrete prior to placing insulating blankets.
3) Use a method of protection and materials that will maintain the concrete temperature above 40°F.

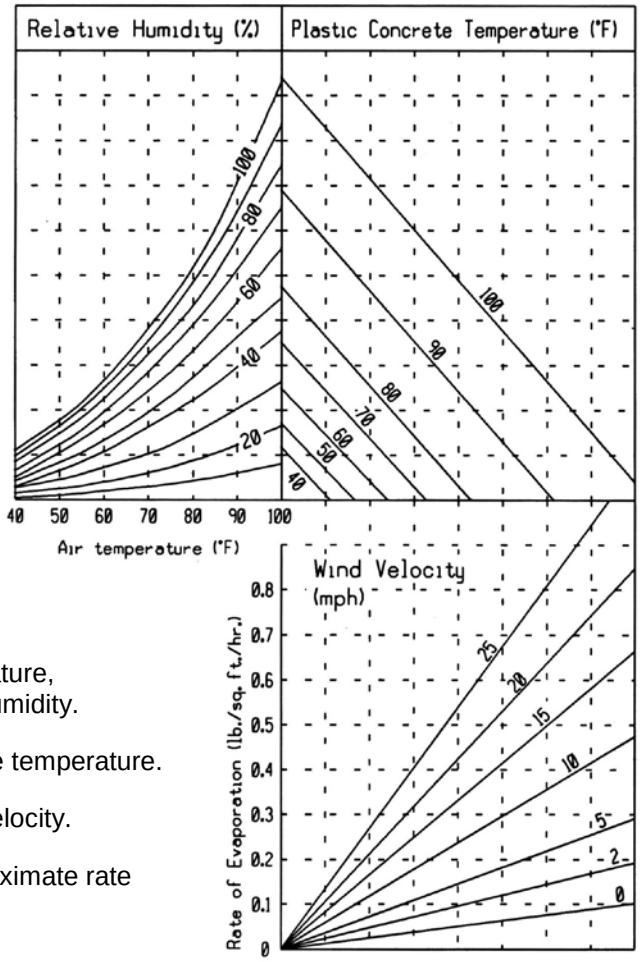
2. Hot Weather: Hot weather condition is defined as any combination of the following conditions that tend to impair the quality of plastic concrete by accelerating the rate of moisture loss and rate of cement hydration causing thermal shrinkage and resulting in plastic shrinkage cracking:

- High Ambient Temperature
- High Concrete Temperature
- Low Relative Humidity
- High Wind Velocity
- Solar Radiation

a. General:
1) During hot weather conditions, the Engineer may restrict concrete placement to early morning or evening hours.
2) During hot weather conditions, advise the Engineer of the results of the theoretical evaporation rate throughout paving operations.

b. Determine the Theoretical Rate of Evaporation: Use the following chart and the National Weather Service's predicted maximum air temperature, relative humidity, and maximum steady wind velocity without gusts, for the date and the location of the paving pour.

Theoretical Rate of Evaporation Chart



To Use this Chart:

1. Enter with air temperature, move up to relative humidity.
2. Move right to concrete temperature.
3. Move down to wind velocity.
4. Move left , read approximate rate of evaporation

c. If the evaporation rate exceeds 0.1 pounds per square foot per hour but is less than 0.3 pounds per square foot per hour, provide the following concrete evaporation protection.
   1) Immediately apply an approved evaporation retarder to the concrete pavement and curbs or increase the surface cure application to 1.5 times the standard specified rate.
   2) Take special precautions to ensure that the forms and subgrade are sufficiently moist or protected to avoid lowering the water content at the pavement/subgrade interface. In hot weather conditions, moisten the subgrade the evening before operations.
   3) Ensure that the time between placing and curing is minimized and eliminate delays.
   4) Moisten concrete aggregates that are dry and absorptive.
   5) Use a fog spray to raise the relative humidity of the ambient air if there is a delay in immediately applying the curing compound.
   6) Minimize solar heat by shading, wetting, or covering concrete chutes or other equipment that comes in contact with plastic concrete.

d. If the evaporation rate is 0.3 pounds per square foot per hour or greater or if winds are greater than 25mph, discontinue placement of concrete.

3. Rain Protection:

a. The Contractor shall have available, near the site of the work, materials for proper protection of the edges and surface of concrete. Protective material may consist of sheets of burlap, or plastic film. Planks or other material with suitable stakes that can be used as temporary forms shall also be on hand.

b. If initial set has not occurred, contractor shall take every precaution necessary to protect the surface texture of the concrete.

c. Failure to properly protect concrete shall constitute cause for removal and replacement of defective pavement, if so determined by the Engineer.

C. Protection from Traffic:

1. General:

a. Protect the new pavement and its appurtenances from traffic, both public and that caused by the Contractor's own employees and agents, at no additional cost to the Owner. This includes the erection and maintenance of warning signs, lights, barricades, watchmen to direct traffic, and pavement bridges or crossovers.

b. Do not operate equipment with metal tracks, metal bucket blades, or metal motor patrol blades directly on new paving. Do not unload soil or granular materials, including base rock for storage and future reloading directly onto new paving.

2. End of Day's Run:

a. At the end of each day's run and at all side streets, erect and maintain safety barriers and fencing as necessary to protect the pavement from damage.

b. Install safety fences within 1 hour of the completion of finishing and curing operations. Leave fences in place and maintained until the concrete has attained the minimum strength or age.

c. Intermediate safety fences may be required for the purpose of opening the pavement for access to a side road, side street, or entrance.

3. Repair of Damages: At the discretion of the Engineer, and at no additional cost to the Owner, repair or replace any part of the pavement damaged by traffic or other causes occurring prior to final acceptance of the pavement.

1.09 USE OF PAVEMENT

Time for opening pavement for use is determined by age and test results from cylinder or beams taken during placement.

Minimum Age and Tested Strength of Pavement Before Opening

Class of Mix	Type of Cement	Minimum Age For Opening (1)	Minimum Compressive Strength (psi)	Minimum Flexural Strength Center Point (psi)
C	Type I	7 Days (2)	3,000	500
M	Type I	48 Hours	3,000	500

(1) Opening without testing only allowed upon approval of Engineer

(2) Five calendar days for concrete 9 inches thick or more.

PART 2 PRODUCTS

2.01 CONCRETE STRENGTH:

A. Concrete mix for exterior slabs and steps:
   1. Minimum of 4000 psi compressive strength at twenty-eight (28) days.
   2. Minimum air content of 6.0%. To allow for loss during placement, the air content of fresh, un-vibrated concrete shall be 7.0%.
   3. Maximum of 15% replacement of cement with fly ash will be permitted.
   4. Slump four inches (4") maximum.

2.02 MIXING:

A. Except as otherwise specified, concrete shall be ready-mixed or job-mixed at the Contractor's option, and in accordance with requirements of ACI 318-77. Ready-mixed concrete shall be mixed and delivered to the project in accordance with ASTM C94. Maximum mixing time is one (1) hour.

2.03 PORTLAND CEMENT:

A. ASTM C150, type I.

2.04 SAND:

A. Clean, hard, washed and well graded. Sand shall conform with ASTM C33.

2.05 COARSE AGGREGATE:

A. Aggregate shall conform to ASTM C33. Aggregate for footings and other unexposed concrete may be gravel. Aggregate for exterior concrete and surfaces shall be limestone (max. size 1"). No substitutions will be allowed. Evidence of staining due to impurities will be cause for rejection of work.

2.06 MIXING WATER:

A. Clean and free from oil, acid and injurious amounts of vegetable matter, alkalies and other impurities.

2.07 ADMIXTURES:

A. Air entrainment: 6%, + 1% or -0.5%.

B. Air-entraining agents shall conform to ASTM C260.

C. Calcium Chloride is not to be used. No other admixtures shall be used without the expressed, written consent of the Engineer.

D. A water-reducing agent may be used as deemed necessary, to be in conformance with the latest ASTM requirements.

2.08 EXPANSION JOINT FILLERS:

A. See Specification Section 32 13 73.

2.09 EXPANSION JOINT SEALANT:

A. See Specification Section 32 13 73.

2.10 CURE AND SEAL:

A. Comply with Iowa DOT Section 4105.
   a. All colored concrete pavement shall be cured using Iowa DOT 4105.07, Clear Compounds conforming with AASHTO 148, Type 1-D, Class A.
   b. All standard color concrete pavement shall be cured using Iowa DOT 4105.05, White Pigmented Compounds applied at a rate of 0.067 gallons per square yard.

2.11 REINFORCING STEEL MATERIAL:

A. All reinforcing steel shall be epoxy coated and conform with Iowa DOT section 4151.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION:

A. Excavate, fill, compact, grade and prepare subgrade as specified in Earthwork Section 31 20 00.

B 1. Unless otherwise ordered by the Engineer, the subgrade, at time of placing concrete for Concrete Pavement, shall be in a uniformly moist but not muddy condition to a depth of not less than one inch.

2. Subgrade Loading:
   a. Where concrete trucks must travel on a prepared soil-type subgrade to unload and, as approved by the Engineer, watering of the subgrade must be limited to just ahead of the paving machine.
   b. Repetitive loading on the subgrade by concrete trucks shall be minimized by entering and exiting the subgrade on side streets.
   c. Loads in excess of the legal axle load shall not be allowed on the completed subgrade.
   d. Partially loaded trucks may be required.
   e. If subgrade/subbase failure occurs, the repair shall be coordinated with the Engineer.

3. Paving Suspended:
   a. The paving operation shall be suspended where subgrade stability has been lost.
   b. No concrete shall be placed upon a subgrade which has become unstable, bears ruts or tire marks of Contractor's equipment or which is excessively softened by rain until such subgrade has been reconsolidated and replaned or reshaped to correct the objectionable condition.
   c. If necessary, scarify to a minimum depth of 6 inches, aerating, and recompacting at the Contractor's expense. Recompaction shall meet requirements of Section 31 20 00.

4. Maintenance of Subgrade:
   a. The Contractor is responsible for maintenance of the completed subgrade during subsequent construction activities.
   b. Before allowing hauling equipment to use the completed subgrade, the Contractor must be satisfied as to the effect this hauling equipment may have on the partially completed work.

3.02 SURFACE FIXTURE ADJUSTMENT

A. Adjust manhole frames and other fixtures within area to be paved to conform to finished surface.

B. Clean outside of fixture to depth of pavement before concrete placement.

C. Box out fixtures for later adjustment where allowed. Size and shape of box out for intakes as shown in Standard Drawings.

3.03 FORMS:

A. Set base of forms at or below subgrade elevation with top of forms at pavement surface elevation.

C. Extra height forms with Engineer approval may be used to back up integral curb and paving slab; set base at or below subgrade elevation with top of form at top of curb elevation.

D. Secure forms in place to required grade and alignment.

E. If voids occur under forms, remove forms and rework subgrade to proper elevation and density; reinstall forms.

F. If the soil supporting the form is softened by rain or standing water so that form is inadequately supported, remove forms and rework subgrade to proper elevation and density; reinstall forms.

G. Coat forms with release agent before concrete is placed.

H. Place forms true to alignment and free of latent concrete. Use wood or steel forms adequately staked and braced for all exposed slab edges.

I. Leave forms in place not less than eight (8) hours after concrete is placed. If removal causes damage to concrete, leave forms on as long as necessary to prevent damage. Remove forms with care to prevent cracking, spalling or overstressing concrete.

3.04 REINFORCING PLACEMENT

A. Reinforcing metal shall be clean, straight, free from distortion and rust, and shall be firmly secured in position as detailed.

B. All reinforcing metal shall be placed in approved storage to prevent damage; do not distribute along the work site except as needed to avoid delay in paving.

C. Place reinforcing steel as shown on the detailed drawings or as specified; support and secure bars by approved chair and wire assemblies; bars to be checked by the Engineer upon notification from the Contractor.

D. Place steel centered in the pavement reasonably in advance of the paving operations.

E. Joint Steel:

1. LONGITUDINAL: All joints shall be constructed of the type, dimensions, and at the locations required by the plans or special provisions. All longitudinal joints in drive lanes shall be L-1 or L-2 joints and have steel, unless specifically specified otherwise on plans. Interior, parking lot joints do not need steel and shall be of type C.

2. TRANSVERSE: All transverse joints shall be either type C or type DW with steel for a day's work joint.

2. Tie bars for all longitudinal joints shall be installed so as to be in the intended position in the completed pavement. Tie bars for all longitudinal joints shall be positioned on chairs and secured against movement with metal stakes during placing and finishing of concrete unless otherwise approved by the Engineer. If approved by the Engineer, bars may be placed in position by a machine or other method. For tie steel that is placed mechanically in plastic concrete, the Engineer may:
   a. Manually check locations and depth of the steel in the plastic concrete behind the slip form paver using the following frequencies:
      - once every 200 lineal feet for tangent roadway sections
      - in at least three locations within all horizontal curve sections
      - for each inspection, at least two tie steel locations within a panel
   b. Using a magnetic locator, verify locations of tie steel in hardened concrete every day. Check out-of-tolerance tie steel to identify the extent of the problem for a retrofit correction.

3. The Contractor shall provide adequate means to ensure that the load transfer devices and tie bars are properly secured to maintain correct position and alignment during the placement of concrete.

4. Other tie bars shall be placed in such a manner as to ensure that the bars are located in reasonably close conformity with the specifications.

5. Care should be taken to prevent disturbance or damage of the joint assembly. Bars must be supported by approved chairs or method approved by Engineer.

3.05 JOINTS:

A. The Contractor shall submit a concrete jointing plan to the Owners Representative for approval 10 days prior to the start of paving. Joint design for concrete pavement shall be based on the current Guide for Design and Construction of Concrete Parking Lots published by the American Concrete Institute (ACI 330R-92). It is desired to have joint lines match edges of travel lanes. Joint locations shall be chalked with a string line before sawing.

B. Saw cut control joints. Joints to be 1/8" minimum and 1/4" maximum width. All transverse contraction joints shall be sawed at a maximum spacing of 30T, where T is the thickness of the pavement in feet. In sidewalks, space joints to create square panels unless a maximum spacing of 21T is exceeded, then use rectangular panels, unless shown on the plans. All walks 13' or more in wide shall get a longitudinal centerline L-1 Joint with Steel and square panels.

All joints shall be sawed to a depth shown below.

	Minimum Sawcut Depth	
	Conventional Saw	Early "Green" Saw
Transverse "C" Joint	T/4±1/4"	1 1/4"
Longitudinal Joint	T/3±1/4"	Not Allowed

C. Timing:

1. Begin transverse joint sawing as soon as the concrete has hardened sufficiently to allow sawing without raveling or moving of aggregate. Saw joints before uncontrolled cracking takes place.

2. Saw all joints in a single cutting operation for a specific joint. Make saw cuts true to line and to the dimensions specified in the contract documents.

3. Discontinue sawing a joint if a crack develops ahead of the saw.

4.Saw longitudinal joints within 24 hours of the concrete being placed.

5. If necessary, continue the sawing operations both day and night.

6. The concrete must be capable of supporting the sawing operations to allow the use of an early green concrete saw.

7. Replace pavement with uncontrolled or random cracking at no additional cost to the Owner. Replace complete panel sections by means used for Full Depth PCC Repair Patches. Thickness of repair shall be original design thickness plus 2 inches. Place RD joints as shown in SUDAS Detail 7040.10 for patch.

8. Use wet sawing for dust control when specified in the contract documents.

D. Round outside edges of sidewalk with edging tool with approximately one quarter-inch (1/4") radius.

E. Round edges of sidewalk or curbs adjacent to expansion joints with edging tool with approximately one-eighth inch (1/8") radius.

F. Construction Joint - and tied joints shall be used at ends of all concrete pours. Bars to extend through joints a minimum of twenty-four (24) bar diameters.

G. Expansion joints (isolation joints) shall be installed in concrete pavement slabs and sidewalks where the concrete meets other structures such as light pole bases, intakes, buildings and all other similar structures. Hold joint material down one-half inch (1/2") and fill with sealant. Also used where sidewalk meets concrete curb.

H. Joints sawed with an early "green" concrete saw shall be washed out prior to sealing. The concrete must be capable of supporting the sawing operations to allow the use of an early green concrete saw.

I. Construction Joints:

1. Longitudinal or transverse construction joints shall be placed between adjacent lanes of concrete and at end-of-day header runs.

2. Manhole boxouts shall be located and placed on grade prior to paving. Manhole boxouts are required for two piece castings for sanitary/storm manholes.

3. The longitudinal construction joints shall be an approved joint type with legs unless machine placed.

4. Transverse construction joints shall employ load transfer devices (Header) and shall be placed whenever concrete placement is delayed for more than 30 minutes.

3.06 CONCRETE PAVEMENT PLACEMENT

A. Set survey control stakes at 25 foot maximum spacing including high and low points. Additional staking

may be required by the Engineer.

B. The concrete shall be placed, consolidated, and finished to the widths and depths outlined in the plans.

B. All Type 2 and Type 3 paving sections longer that 100' in length shall be poured with the slab in a single slip-form paving machine operation. This includes, but not limited to all 10' wide or greater trails longer than 250 feet in length.

D. The concrete shall be deposited upon the supported reinforcement keeping segregation to a minimum.

E. Concrete shall be deposited to the full depth of the pavement in a single operation.

F. Necessary hand spading and spreading shall be done with shovels and not rakes.

G. Use laser screed for all Type 1 uniform width slabs 8.5 feet or more in width and 250 feet or more in length.

H. When pavement is constructed in separate lanes, the junction line in straight sections shall not deviate from the true line shown on the plans by more than ½ inch at any point and shall be tooled to the radius shown on the plans.

I. Place concrete to full depth in single operation. Keep a uniform pile of concrete in front of the paving machine, up to a maximum of 6 to 8 inches above the design surface elevation.

J. The concrete shall be distributed and spread as soon as placed. A mechanical concrete spreader may be used.

K. Concrete Screed:

1. The concrete shall then be struck off and screeded by mechanical means.

2. The striking off or screeding shall conform to the crown and cross section shown on the plans.

3. If, in the operation of subgrade or finishing equipment, it is necessary to operate one or both sets of wheels or tracks on previously placed concrete, the wheels or tracks shall be adjusted so that the bearing on the concrete will be not less than 3 inches from the edge of the pavement.

4. When operating with two wheels on the previously placed concrete and two wheels on the form, the form wheels shall be double flanged.

5. All wheels operating on the pavement shall be flangeless and rubber tired. All tracks operating on the pavement shall use rubber, wood, or belting pads.

L. The top of the forms shall be kept clean from accumulations of concrete, and the travel of the finishing machine on the forms shall be maintained true without lift, wobbling, or other variations tending to affect precision of finish.

M. When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval the Engineer. Vibrating equipment shall meet the requirements of IDOT Section 2301.07. Vibrating equipment shall, under no circumstances, be used as a

tool for moving concrete laterally on the grade.

3.07 FINISHING:

A. Screed, level and float all slabs to true, level and straight lines.

B. Exterior slabs and platforms to be medium hair broom finish, with no coarse aggregate visible, unless otherwise specified on drawings.

C. Tolerances on all surfaces not more than three-sixteenths inch (3/16") in ten foot zero inch (10'- 0").

D. Formed surface finish:
   1. Remove bulges, fins, form marks and roughness from exposed surfaces by grinding.
   2. Subject to Engineer's approval, fill honeycombed and other defective areas by cutting out to solid concrete (minimum depth= 1") with straight edges and at right angles to the surface. Dampen area to be patched, brush on grout of equal parts Portland Cement and sand and follow immediately with patching mortar. Large or objectionable areas will require full removal and replacement at Engineer's discretion.
   3. Patching mortar to be not richer than one (1) part Portland Cement to three (3) parts sand. Color of patching mortar shall match the adjacent concrete. (Substitute white Portland Cement for part of the grey cement as needed to provide color match.)
   4. Trowel or burlap rub patched areas to match the surrounding concrete area. Clean all walls upon completion.
   5. Exposed concrete wall faces and tops to have a uniform smooth rubbed finish. Moisten concrete surfaces and rub with Carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.

3.08 SURFACE CURING

A. Apply liquid curing compound in a fine spray to form a continuous, uniform film on the horizontal surface and vertical edges of pavement, curbs and back of curbs immediately after surface moisture has disappeared, but no later than 30 minutes after finishing. With approval of the Engineer, the timing of cure application may be adjusted due to varying weather conditions and concrete mix properties to ensure acceptable macrotexture is achieved.

   1. Use a white pigment liquid curing compound.

B. Apply compound with power sprayer; rate of application not less than 0.067 gallon per square yard (15 square yards per gallon); do not dilute compound.

C. If forms are used, apply to pavement edges and back of curbs within 30 minutes after forms are removed.

D. Ensure liquid curing materials are well agitated in the supply drum or tank immediately before transfer to the sprayer. Keep curing materials well agitated during application.

E. Hand operated sprayers may be used for small and irregular areas.

G. If forms are used, apply to pavement edges and back of curbs within 30 minutes after forms are removed.

H. If, due to other operations, the coating is damaged within 72 hours after being applied, immediately re-coat the affected areas. Coating of the sawed surface with curing compound will not be allowed on joints that

are to be sealed. When pavement is opened to traffic prior to 72 hours after application of the curing coating, a re-coating will not be required.

3.09 JOINT SEALING

A. Timing:

1. Unless otherwise provided, before any portion of the pavement is opened to the Contractor's forces or to general traffic, joints that require sealing shall be sealed.

2. The Engineer may limit the wheel loads and axle loads of equipment operating on the pavement during this operation, if prior to the age and strength specified in Section 1.08 above. Additional tests to determine the modulus of rupture may be required.

B. Cleaning:

1. For those joints that are not to be sealed, cleaning is not required.

2. Within 3 hours after a joint has been wet sawed to the finished dimension, flush the wet sawing residue away from the sawed faces using a high pressure water blast operating with a minimum pressure of 1,000 pounds per square inch. Within 3 hours after a joint has been dry sawed to the finished dimension, blow the dry sawing residue from the joint using air compressors that provide moisture and oil free compressed air.

3. Immediately prior to installation of sealant, clean joints with an air blast. Do not perform sealing until visual examination verifies the joint surfaces appear dry, in addition to being clear of dust and contamination.

C. Sealing:

1. Prepare and install joint sealer in the joint and to the proper level specified in the contract documents and as recommended by the manufacturer.

2. Heat hot-poured sealers in a thermostatically controlled heating kettle; heat the material to the temperature required for use, but not above that recommended by the manufacturer. After sealing, remove excess sealer from the pavement surface.

3. Seal joints the same day they are cleaned. Apply sealant only when the joint surfaces appear dry by visual examination.

4. Place joint sealer only when the pavement and ambient air temperatures are 40°F or above. When near this minimum, additional air blasting or drying time, or both, may be necessary to ensure a satisfactory bond to the joint faces. When this sealer cannot be properly placed due to late fall work, submit a joint construction plan and sealing details to the Engineer for approval before commencing paving. Delay the cleaning, sealing, and, if required, resawing of joints until the following spring. This delay requires the Engineer’s approval.

5. When surface correction is required, repair seals damaged from the corrective work. Joint preparation, cleaning, and sealing may be delayed until after corrective work, provided the pavement is not opened to traffic before corrective work is performed.
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3.10 SEPARATE CURB AND GUTTER CONSTRUCTION (FOR USE WITH HMA PAVING AREAS)

A. Construct curb and gutter as shown on drawings.

B. Use paving machine slip-form for curb; curb mule or similar mechanical equipment providing equivalent results.

C. Hand methods shall be allowed for radius, returns, and sections of curb and gutter 75 feet or less in length.

D. When depressed curb at driveways and where sidewalk intersects street, use templates to form backs of such curbs.

E. Form and construct curb by hand only where barrier or depressed curb is required and where small radii or other special sections preclude use of mechanical equipment.

F. Finish curb as rapidly as finishing operations on pavement permit. Maximum distance behind paving machine is 100 feet.

G. Remove free water, latency, dust, leaves, or other foreign matter prior to placing concrete for curb.

H. Use freshly mixed concrete; do not store concrete in receptacles at side of pavement for use in curb at a later time; do not use concrete requiring retempering.

I. Vibrate or puddle concrete to secure bond with paving slab and eliminate rock pockets.

J. Secure final finish on curbs by hand method, including 6 foot straightedge or 6 foot slipform.

K. Edge, protect, and cure curb in same manner as pavement.

L. Check surfaces of curb and gutter with 10 foot straightedge; correct variations greater than 1/8 inch; remove and replace curbs having varying cross section.

3.11 DEFECTS OR DEFICIENCIES

Pavement containing cracks, fractures, spalls, or other defects, as determined to be unacceptable by Owner/Engineer, shall be removed and replaced at no cost to Owner. Remedy to be determined by Engineer. In lieu of the above, the Owner/Engineer may approve an extended warranty or price adjustment.

Replace pavement with uncontrolled or random cracking at no additional cost to the Owner. Replace complete panel sections by means used for Full Depth PCC Repair Patches. Thickness of repair shall be original design thickness plus 2 inches. All matches must conform to Iowa SUDAS 2013 Detail 7040.101 for patches.

END OF SECTION

SECTION 32 13 73

PAVEMENT JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Expansion and contraction joints within cement concrete pavement.
   2. Joints between cement concrete and asphalt pavement.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each type and color of joint sealant required.

C. Product test reports.

D. Compatibility and Adhesion Test Reports: From sealant manufacturer.

1.03 QUALITY ASSURANCE

A. Preconstruction Compatibility and Adhesion Testing: Submit samples of materials that will contact or affect joint sealants to joint-sealant manufacturers for testing according to ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.

1.04 WARRANTY

A. Provide two-year warranty from time of substantial completion for polyurethane sealants. Include coverage for installed sealants which fail to achieve watertight seal, exhibit loss of adhesion or cohesion, and sealants which do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

   1. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Colors of Exposed Joint Sealants: gray, unless selected by Architect from manufacturer's full range.

2.03 POURED JOINT SEALANTS

A. Parking Lot Pavement, Longitudinal and Transverse Joints:
1. Products:
   a. Bemac, Div. of McAsphalt; Beram 195/195LM.
   b. CRAFCO; ROAD SAVER 231.
   c. Koch Pavement Solutions; Koch Product #9030
   d. Maxwell Products, Inc.; Elastoflex 71.
   e. P.T.Products; DURA FILL 3405 LM.
   f. W.R.Meadows; 3405 Modified (Hot Pour)
   g. WRM SOF SEAL (2Comp. Cold Pour)
   h. Or equal specifically approved by engineer.

B. Expansion Joints in Walks and Parking
2. Products:
   a. Sonneborn Products; Sonolastic SL-1. Color gray.
   b. Or equal specifically approved by engineer.

2.05 EXPANSION JOINT FILLERS

A. Non-Linear Expansion Joints
   1. Polyethylene closed cell foam expansion joint filler. BASF, Sonoflex F.
   2. Only allowed at small curved joints, such as bollards or roof drain downspouts.
   3. Or equal specifically approved by engineer.

B. Linear Expansion Joints
   1. Resilient joint fibrous expansion board joint filler. Formflex Expansion Joint.
   2. Or equally specifically approved by engineer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Timing: Unless otherwise provided, before any portion of the pavement is opened to the Contractor's forces or to general traffic, expansion joints and sawn joints shall be sealed.

B. Cleaning:
1. Before sealing joints narrower than 3/8 inch, the residue from sawing shall be cleaned from the crack. Dry sawing residue shall be blown from the joint. Wet sawing residue shall be flushed away by high pressure water blast cleaning.
2. For joints 3/8 inch wide or wider, sand cleaning shall be used. When the joint surfaces appear dry by visual examination, the upper 3/4 inch of each joint face shall be cleaned by sand blast methods, followed by joint cleaning with air blasting. Air compressor shall provide moisture and oil-free compressed air. The angle of approach of the sand blast nozzle to each vertical face of the reservoir shall be approximately 30 degrees and the sand blast nozzle must have a guide which inserts in the joint and assures positive location and directional control of the nozzle.
3. Joint Sealer:
   a. Joint sealer shall be prepared and installed in the joint and to the proper level as shown in the contract documents and as recommended by the manufacturer.
   b. Hot-poured sealers shall be heated in a thermostatically controlled heating kettle; the material shall be heated to the temperature required for use, but not above that recommended by the manufacturer. After sealing, excess sealer shall be removed from the pavement surface.
   c. Joint sealer shall be placed only when the pavement and ambient air temperatures are 40 degrees Fahrenheit or higher. When near this minimum, additional air

blasting or drying time or both may be necessary to assure a satisfactory bond to the joint surfaces.

d. When this sealer cannot be properly placed due to late fall work, the Contractor shall submit a joint construction plan and sealing details to the Jurisdictional Engineer for approval before paving can begin.

e. Joints shall be sealed the same day they are cleaned. Sealing shall be done only when the joint surfaces appear dry by visual examination.

f. Where a curb does not exist, the joint opening at the pavement edges shall be sealed with tape.

g. If surface correction required the joints may need to be recleaned and resealed.

C. Install backer materials to support sealants during application and at position required to produce optimum sealant movement capability. Do not leave gaps between ends of backer materials. Do not stretch, twist, puncture, or tear backer materials. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.

D. Install sealants at the same time backings are installed to completely fill recesses provided for each joint configuration and to produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pavement Markings.

1.02 DESCRIPTION OF WORK

A. For marking of completed pavement surfaces.

1.03 SUBMITTALS

A. Minimum of two weeks prior to commencing any pavement marking operations, the Contractor shall submit a manufacture's catalogue sheet for each type of pavement marking paint used for review and approval by the Engineer.

1.04 SCHEDULING AND CONFLICTS

A. Construction Sequence:
   1. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
   1. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

C. Conform to Local, State and Federal Requirements.

1.05 RESTRICTIONS ON OPERATIONS

A. Surface Temperature Restrictions: Pavement markings shall not be placed when the temperature of the pavement surface is less than 40 degrees Fahrenheit, or between October 15th and April 1st.

PART 2 PRODUCTS

2.01 Waterborne Paint

A. The paint shall be capable of being heated and sprayed applied up to a temperature of 140° F without damaging the formulation or serviceability of the paint. The paint shall be free from heavy metals as defined by the U.S. EPA.

B. Pigment Content: The percent pigment by weight of the finished product shall be from 45% to 55% by weight for white and 55% to 58% for yellow paint as tested by ASTM D 3723.

C. Resin Solids shall be composed of 100% acrylic emulsion polymer.

D. Nonvolatile Vehicle: The nonvolatile vehicle shall not be less than 43% by weight for white paint and not less than 45% by weight for yellow paint.

E. Volatile Organic Compounds: Volatile organic compounds shall not exceed 1.25 pounds per gallon excluding water and VOC exempt solids. ASTM D 3960 shall be used to determine the levels of VOCs.

F. Density: The density shall be a minimum of 12 pounds per gallon and the density of the production batches shall not vary more than +/- 0.2 pounds.

G. No-Pick-Up Time: The no-pick-up time for the paint shall be less than 5 minutes.

PART 3 EXECUTION

3.01 CLEANING AND PREPARATION OF PAVEMENT

A. The pavement surface shall be dry and free from dirt, dust, oil and other contaminates which may interfere with the paint from properly bonding to the surface. The clean surface shall be at least 1 inch wider than the anticipated marking. An air blast shall occur immediately prior to the new marking being placed. The air blast is not intended to remove large amounts of dust or dirt, but only a small amount of residue that might be left after the cleaning operation.

3.02 UNIFORM APPLICATION

A. All painted markings shall have uniform thickness and width. The width of the lines shall be as specified with a tolerance of +/- ¼ inch for 4-inch lines and +/- ½ inch for wider lines.

B. The wet film thickness of the paint shall be 14 mils, used at a rate of 305.5 ft. of solid 4” line per gallon of paint.

3.03 TRAFFIC CONTROL

A. Traffic control shall remain in place from the time cleaning operations have started through the completed curing time of the newly applied paint markings.

3.04 MARKING REQUIREMENTS

A. Parking Stalls:
Solid yellow lines, 4 inches wide by length dimensioned on plans and shall be placed for each parking stall as shown in the plans. The spacing shall be nominally 9.5 feet on center, or as otherwise specified on plans.

B. Symbols and Stop Bars:
Symbols, directional arrows, and stop bars shall be painted yellow. Size and shape shall follow the Manual of Uniform Traffic Control Devices. Locations as shown in the plans.

C. Handicap Access Symbols and Aisles:
Symbols, painted yellow, a minimum of 5 feet in height, shall be placed as shown in the plans. Access aisles shall be painted color per plan with a diagonal stripe pattern, lines placed 2 feet apart on center.

D. Loading Zones:
Solid yellow lines 4” wide shall be placed as shown in the plans for loading zones. The lines shall be placed diagonally, spaced 2 feet on center. A solid yellow line shall outline the area on the pavement and on the curb.

END OF SECTION

SECTION 32 91 19

LANDSCAPE GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Final grade topsoil for finish landscaping shown on Landscape Drawings.

1.2 RELATED SECTIONS:

A. EARTHWORK: SECTION 31 20 00

PART 2 PRODUCTS

2.1 MATERIALS:

A. Topsoil: Fertile, friable loam, capable of sustaining vigorous plant growth, from well drained site free from flooding, not in frozen or muddy conditions; reasonably free from subsoil, clay lumps, roots, grass, weeds, stones larger than three-quarter (3/4) inch (19 mm) diameter, and foreign matter; acidity range (pH) of 5.5 to 7.5; containing minimum 4 percent and maximum 20 percent organic matter.

PART 3 EXECUTION

3.1 EXAMINATION:

A. Verify building and trench backfilling has been inspected.

B. Verify subsoil base has been contoured and compacted.

3.2 SUBSOIL PREPARATION:

A. Eliminate uneven areas and low spots.

B. Remove debris, roots, branches, and stones in excess of 1/2 inch (13 mm) in size. Remove subsoil contaminated with petroleum products.

C. Scarify subgrade to depth of 3 inches (75 mm), where topsoil is to be placed. Scarify areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.3 PLACING TOPSOIL:

A. Place topsoil in areas to be seeded or sodded and planted, to thickness as scheduled (Paragraph 3.6).

B. Use topsoil in relatively dry state. Place during dry weather.

C. Fine grade topsoil eliminating rough and low areas. Maintain levels, profiles, and contours of subgrade.

D. Remove roots, weeds, and foreign material while spreading.

E. Manually spread topsoil close to building to prevent damage.

F. Lightly compact placed topsoil.

H. Leave site clean and raked, ready to receive seeding or sodding and landscape planting.

3.4 TOLERANCES:

A. Top of Topsoil: Plus of minus 1/4 inch (6 mm).

3.5 PROTECTION:

A. Protect landscaping and other features remaining as final work.

B. Protect existing structures, walls, sidewalks, and paving.

3.6 IMPORTING TOPSOIL:

A. Use topsoil stockpiled during site stripping for respread.

B. If contractor finds stockpiles have insufficient quantity for respreads requirements, topsoil must be imported to site and included in bid.

3.7 SCHEDULE OF TOPSOIL DEPTHS:

A. The following paragraphs identify compacted topsoil thickness for various locations.
1. Ornamental Grass Planting Beds: Minimum 12 inches
2. Native Plants and Grass Areas: Minimum 8 inches.
3. Shrub Beds: Minimum 8 inches .
4. Turf seeded and sodded Areas: Minimum 8 inches

END OF SECTION

SECTION 32 92 19

SEEDING

PART 1 GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and General Provisions of Contract, including Bidding Requirements, General and Supplementary Conditions and Division I Specification Sections, apply to work specified in this Section.

1.02 WORK INCLUDED:

A. Preparation of seedbed, furnishing and installing fertilizer, seed and mulch, maintenance and guarantee for seeding disturbed areas in accordance with the site plan.

B. Provide all labor, materials, equipment and supervision required to install turf seeding of lawns grass areas.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. EARTHWORK: SECTION 31 20 00.

B. LANDSCAPE GRADING: SECTION 32 91 19

1.04 DEFINITIONS

A. Finish Grade: Elevation of finished surface of topsoil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Subgrade: Surface or elevation of subsoil remaining after completing rough grading, or top surface of a fill or backfill immediately beneath topsoil.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product certificates.

C. Planting Schedule: Indicating anticipated planting dates.

1.06 DELIVERY, STORAGE, AND HANDLING

A. If seed is mixed prior to delivery on the site, it shall be tagged showing a guaranteed statement of composition of mixture and percentage of purity and germination of each variety.

B. If seed is to be mixed at the site, it shall be delivered in original containers bearing producers certification of germination and purity.

C. Tags shall show producers or dealers Iowa Permit Number and date of testing; test date shall be no more than 90 days previous to time of use.

D. Fertilizers shall conform to State of Iowa laws and regulations. If delivered in bulk, bills of lading or other labels shall be furnished to Landscape Architect or labels indicating analysis and weight information from each container shall be preserved and furnished to Landscape Architect within twenty-four (24) hours of application.

E. Handling of materials as recommended by manufacturer.

F. Store all packaged materials off ground and protect from moisture.

G. Storage of all materials in locations designated and approved by Owner

1.06 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

1.07 CODES, INSPECTIONS AND PERMITS:

A. The entire installation shall fully comply with all local and State laws and ordinances, and with all established codes applicable thereto.

1.08 SITE DISTURBANCES:

A. Take precautions to ensure that equipment and vehicles do not disturb or damage existing site grading, walks, drives, utilities, plants, etc.

B. Verify locations and depths of all underground utilities prior to excavation.

C. Repair and/or return to original condition any damage caused by Contractor at no cost to Owner.

1.09 JOB CONDITIONS:

A. Existing Utilities:
   1. Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during this work.
   2. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.

3. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
4. Provide minimum of 48-hour notice to Owner and Landscape Architect and receive written notice to proceed before interrupting any utility.

B. Protection of Persons and Property:
1. Barricade open excavations occurring as part of this work and post with warning lights.
2. Operate warning lights as recommended by authorities having jurisdiction.
3. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by this work.

1.10 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than 60 days from date of Substantial Completion and will include:
1. Repair of eroded areas prior to acceptance.
2. Maintenance of a uniform mulch cover until acceptance.
3. Until final acceptance and approval is received, reseed or overseed, using seed mix originally specified, all seeded areas to produce uniformity.

B. Mow lawn as soon as top growth is tall enough to cut. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Mow at 3" or higher.

PART 2 PRODUCTS

2.01 SEED

A. All seed mixes shall be local ecotypes and be locally obtained from:

United Seeds Inc
1800 Dixon Ave Suite A
Des Moines, Iowa 50316
(800) 365-6674

and shall consist of the following:

1. Seed Mix 1: "Super Turf II" Mix
2. Seed Mix 2: "Super Shade" Mix
3. Seed Mix 3: "Low Grow Grass and Wildflower" Mix (see Section 39 92 19.12 – NATIVE SEEDING)

If an equivalent seed manufacturer and mixture is desired, seed must be approved by project engineer:
Bishop Engineering
3501 104th St
Urbandale, IA 50322
515-276-0467
Attn: David Bentz

All equivalent seed must also be Certified Blue Tag Seed.

2.02 PLANTING MATERIALS

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 3/4 inch or larger in any dimension and other extraneous materials harmful to plant growth.
   1. Topsoil Source: Reuse surface soil stockpiled on-site and supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Verify suitability of stockpiled surface soil to produce topsoil.

B. If necessary Inorganic Soil Amendments:
   1. Lime: ASTM C 602, Class T or O, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.
   2. Aluminum Sulfate: Commercial grade, unadulterated.

C. If necessary Organic Soil Amendments
   1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8.

D. Fertilizer:
   1. 6-24-24 Fertilizer shall be applied to all Type 1 Seeding areas

E. Mulch:
   1. Hydraulic Mulch: Wood cellulose hydraulic mulch with tackifier shall be applied at a rate of 2500lbs/acre.

PART 3 EXECUTION

3.01 LAWN PREPARATION

F. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Apply Superphosphate fertilizer directly to subgrade before loosening.
   2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
   3. Spread planting soil mix to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

G. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.
   3. Remove stones larger than ¾” inch in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

H. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and

fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

I. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

J. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.02 SEEDING/ MULCHING

A. Seeding rates according to United Seed specifications or at rate as specified on Landscape plan, rate on Landscape Plan governs.

B. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.

C. Apply wood cellulose Hydraulic Mulch at rate of 2500 lbs/ acre.

3.02 FERTILIZING

A. Fertilize all seed type I areas with product specified above at rate of 250 lbs/ acre.

3.03 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches.

B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

END OF SECTION

SECTION 33 31 00

SANITARY SEWERAGE PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sanitary sewer drainage piping, fittings, accessories and bedding.

B. Connection of project sanitary drainage system to the municipal sanitary sewer system.

C. Clean-out and access structures.

1.02 RELATED DOCUMENTS:

A. The Contract Documents, as defined in Section 01 11 00 - Summary of Work, apply to the Work of this Section. Additional requirements and information necessary to complete the Work of this Section may be found in other Documents.

1.03 RELATED SECTIONS:

A. Section 31 23 33, Trenching and Backfilling.

1.04 REFERENCES

A. American Association of State Highway and transportation Officials (AASHTO):
   1. AASHTO M294 - Corrugated Polyethylene Pipe, 300-1200 mm Diameter.
   2. AASHTO M252 - Corrugated Polyethylene Drainage Pipe.

B. American National Standards Institute (ANSI):
   1. ANSI A21.14 - Ductile Iron Fittings, 3-Inch Through 24-Inch, for Gas.

C. American Society for Testing and Materials (ASTM):
   1. ASTM C 12 - Practice for Installing Vitrified Clay Pipe Lines.
   2. ASTM C 14 - Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   3. ASTM C 76 - Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   4. ASTM C 425 - Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
   5. ASTM C 443 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   6. ASTM D 3034 - Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
   7. ASTM A 746 - Specification for Ductile Iron Gravity Sewer Pipe.
   8. ASTM C 700 - Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and perforated.
   9. ASTM F 477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.05 DEFINITIONS

A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.06 SUBMITTALS

A. Section 01 35 16 – Alteration Project Procedures: Procedures for submittals.
   1. Product Data: Data for each type of pipe and pipe accessory specified.

B. Section 01 78 00 - Closeout Submittals: Procedures for closeout submittals.

1. Project Record Documents: Accurately record the following.
   a. Actual locations of pipe runs, connections, manholes, cleanouts, and invert elevations.
   b. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.07 QUALITY ASSURANCE

A. Regulatory Requirements: Perform work in accordance with utility company requirements and applicable health codes and authority having jurisdiction requirements.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. All pipe and materials shall comply with the local jurisdiction's Plumbing Code and SUDAS.

B. Ductile Iron Pipe:
   1. Pipe: Class 52, conforming to AWWA C151/ANSI A21.51, inside nominal diameter as indicated on Drawings with bell and spigot end.
   2. Pipe Joint: AWWA C111/ANSI A21.11, rubber gasket joint devices.

C. Solid Wall Polyvinyl Chloride Pipe (PVC) 8 inch to 15 inch:
   1 Comply with ASTM D 3034, pipe stiffness per ASTM D 2412, minimum thickness solid wall pipe, SDR 23.5 (153 psi), 26 (115 psi), 35 (46 psi).
   2 PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
   3 Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

D. Solid Wall Polyvinyl Chloride Pipe (PVC) 18 inch to 27 inch:
   1 Comply with ASTM F 679. Minimum pipe stiffness of 46 psi as per ASTM D 2412.
   2 PVC plastic meeting ASTM D 1784, Cell Classification 12454 or 12364. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.
   3 Integral bell and spigot joints with elastomeric seals complying with ASTM D 3212 and ASTM F 477.

E. Polyvinyl Chloride Composite Pipe (truss type PVC) 8 inch to 15 inch:
   1 Comply with ASTM D 2680 (composite pipe), minimum pipe stiffness 200 psi. Pipe constructed with truss-type structure between inner and outer PVC walls with voids filled with lightweight concrete.
   2 PVC plastic meeting ASTM D 1784, Cell Classification 12454. Do not exceed 10 parts by weight per 100 of PVC resin in the compound for additives and fillers, including but not limited to stabilizers, antioxidants, lubricants, and colorants.

2.02 PIPE ACCESSORIES

A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.

B. Fittings: Mechanical Joint Cast Iron Fittings.

C. Trace Wire: Refer to Section 31 23 33 Part 3.11 for general tracer system requirements.

D. Pipe Markers: Aluminum Foil core for non-ferric metal detectable conductor, clear brightly colored plastic covered, imprinted with "SEWER SERVICE" in large letters.

E. Protect all ductile iron pipe and fittings with 8 mil polyethylene wrap conforming to AWWA C105/ANSI A21.5.

2.03 CLEANOUTS AND MANHOLES

A. Lid and Frame: Heavy duty cast iron with removable lid as indicated on Drawings.

B. Shaft Construction: Cast Iron shaft of internal diameter as indicated on Drawings with 3500 psi concrete collar for cleanouts.

C. Manhole pipe connections shall include flexible, watertight gasket cast integrally with barrel sections per ASTM C923.

PART 1 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.
1. Verify trench cut, excavations, dimensions, and elevations are as indicated on Drawings.

B. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.

B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.03 BEDDING

A. Excavate pipe trench and place bedding material in accordance with Section 31 23 33 for work of this Section.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches compacted depth, each layer. Place compacted bedding material to elevation of paving subgrade as indicated on Drawings.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

D. Remove excess backfill and excavated material from site.

3.04 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with ASTM C 12, ASTM C 14, manufacturer's published instructions and state or local requirements. Seal joints watertight.

B. Install pipe on minimum 4 inch bedding as specified in Section 31 23 33.

C. Lay pipe to slope gradients indicated on Drawings.

D. Refer to Section 31 23 33 for trenching requirements. Do not displace or damage pipe when compacting.

E. Connect to building sanitary sewer outlet and municipal sewer system as indicated on Drawings.

F. Refer to Section 31 23 33 Part 3.11 for general tracer system requirements.

3.05 INSTALLATION - CLEANOUTS

A. Form bottom of excavation clean and smooth to elevation indicated on Drawings.

B. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe to be placed at required elevations.

C. Mount lid and frame level in grout, secured to top section at elevation indicated.

3.06 SERVICE CONNECTIONS

A. Coordinate the Work with termination of sanitary sewer connection outside building including connection to municipal sanitary sewer system.

B. Connect to existing municipal sanitary sewer system in compliance with utility requirements for new service connections.

3.07 FIELD QUALITY CONTROL

A. Site Tests:
   1. Perform inspections prior to and immediately after placing bedding.
   2. Compaction: Specified in Section 31 23 33.
      a. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.
      b. Frequency of Tests: One test for each 50 lineal feet of trench.
   3. Perform the following tests in accordance with applicable local Public Works Department Standard Specifications and requirements.
      a. Pressure Test.
      b. Infiltration Test
      c. Deflection Test

END OF SECTION

SECTION 33 31 01

SANITARY SEWER MANHOLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Manholes for sanitary sewers.

B. Adjustment of existing manholes.

C. Connection to existing manholes.

D. Abandonment of manholes.

E. Existing Manhole Rehabilitation

1.02 DESCRIPTION OF WORK

A. Construct sanitary and storm sewer manholes, modify existing manholes, and abandon manholes where shown in the Plans.

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings showing compliance with this Specification.

C. Shop drawing schedule of new manholes showing total depth, relative elevations of all connecting sanitary or storm sewer lines, all drops, and orientation of connecting lines.

D. Catalog cuts of iron castings and sewer line connection gaskets.

E. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

C. Precast sections meeting the requirements of ASTM C 478.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:

1. Attend a preconstruction meeting if required by Engineer.

2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:

1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.

2. Complete elements of the work which can affect line and grade in advance of other open cut construction unless noted on plans.

3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and Federal requirements.

C. Sanitary Manholes and Castings:

1. Manhole Types:

Type	Description	Main Pipe Size	Typical Depth	Figure No.
A	48" Min. Dia. Barrel with Eccentric Cone and Integral Precast Base	See Table for Max. Dia. Pipe	No Limit	
E	Poured-in-Place Box	18" or Greater Dia. Pipe	6' - 12'	
F	Combination Poured in Place Manhole with 48" Dia. Riser and Eccentric Cone	18" or Greater Dia. Pipe	12' - 22'	
I	48" Dia. Barrel with Eccentric Cone and Poured in Place Base for Manhole Placement on Existing Sewer	18" Max. Dia. Pipe without Engineer Approval	No Limit	
J	48" Dia. Barrel with Eccentric Cone and T-Section	42" Dia. or Greater Eccentric Reducer Required	8.5' Min.	

2. Ring and Cover Types:

Type	Ring & Cover	No. of Pieces	Bolted Frame	Bolt Cover	Gasketed	Figure No.
A	Standard*	2	Yes	No	Yes	
B	Adjustable**	3	No	No	Yes	
C	Standard*	2	Yes	Yes	Yes	
D	Adjustable**	3	No	Yes	Yes	

* Use when placed in earth fill, asphalt pavement, or ACC manhole boxout.
** Use when placed in PCC pavement or PCC manhole boxout.

1.08 MEASUREMENT FOR PAYMENT

All measurements for payments will be made by the Engineer or authorized representative.

A. Manhole: For each type and size of manhole required and furnished, measure manhole vertical dimension in feet from the flow line to the top of the ring casting. Payment shall be at the unit bid price for each type and size of manhole properly installed. The unit bid price for manholes shall include all bedding, backfill, compaction and all appurtenances including castings and lids necessary for the proper installation.

B. Drop Connection: Measure vertical feet of drop, from the flow line of the incoming sewer to the flow line of the drop at its entry into the manhole, for each size of sewer line. Payment shall be at the unit bid price for vertical feet of drop per size of sewer line.

C. Manhole Adjustment, Minor: Removal or addition of Manhole adjusting rings are considered an incidental item to manholes, unless otherwise specified as a pay item in the contract documents. If specified as a pay item, it shall be at the unit price bid for each adjustment. If so specified, count the number of manholes adjusted to finished grade by raising or lowering an adjustable casting or by addition or removal of manhole adjusting rings.

D. Manhole Adjustment, Major: Count the number of manholes adjusted to grade by addition or removal of manhole barrel, cone or flat top sections, or the exchange of existing sections with sections having revised vertical dimensions. Count separately the cast in place manholes that will require removal of concrete to accommodate adjustment. Payment shall be at the bid price for each major adjustment.

E. Connection to Existing Manhole: Count the number of connections made to existing manholes. Payment shall be at the unit bid price for each connection.

F. Abandoned Manhole: Count the number of manholes abandoned in place. Payment shall be at the unit bid price for each abandoned manhole. (NOTE: Refer to Section 6020, 3.05 for removal of manholes.)

PART 2 - PRODUCTS

2.01 MANHOLES

A. Placement: Conform to elevations, locations and connection orientations shown on the Plans and detailed drawings.

B. Barrel Diameter, Inside: For sewers up to 24-inch size with two connections use 48 inches diameter barrel or as shown in the contract documents. For larger sewers or more connections,

see Plans and detailed drawings.

C. Wall Thickness: See Detail Plates

D. Coating: Exterior: when exterior waterproof coating is specified, provide bituminous or coal tar coating.

E. Top Configuration: Eccentric top except as noted on the Plans or detailed drawings. Total manhole depth 6 feet or more use cone top section. Total manhole depth less than 6 feet use minimum 9" thick flat top.

F. Joints, Barrel: Male and female ends.
1. Seals, rubber 'O' ring or profile gasket, flexible joint, per ASTM C 443.
2. Apply Bituminous joint compound or butyl sealant wrap meeting ASTM C 877 to all exterior joints.
3. Provide tapered rubber lift hole plug manufactured of SBR with a minimum tensile strength of 800 psi and 80 durometer + or –5.
4. Provide non-shrink grout to cover lift hole plug and to fill interior joints.

G. Concrete: Precast: Comply with ASTM C 478.

H. Base: Precast manhole: Integral base and riser section in accordance with ASTM C 478.

I. Pipe Connection:

1. New Sanitary Sewer Manhole:

   a. Flexible, watertight gasket per ASTM C 923 cast integrally with riser section(s).
   b. Drop connection where required on Plans. See also Detailed Drawings.
   c. When specified, coat interior per 4010, 2.01 F, 5, 6, 8, 9, 10.
   d. Grout internal joint space: non-shrink grout.

2. Existing Sanitary Manhole:

   a. Cored or drilled opening: Provide a flexible, watertight connection that meets and/or exceeds ASTM C 923.
   b. Knock out opening:
      1) Provide a watertight connection (waterstop or other method), meeting the material requirements of ASTM C 923, that is securely attached to the pipe with stainless steel bands or other means.
      2) Grout opening in manhole wall with non-shrink grout.
      3) Pour concrete collar around pipe and outside manhole opening.
      4) Provide flexible pipe joint or flexible connector within 2' of collar.

J. Manhole Steps: None, unless required on the Plans. If required, space steps at 12 to 16 inches, comply with ASTM C 478. Align with vertical side of eccentric cone top section.

2.02 MANHOLE ADJUSTMENT RINGS (Grade rings)

A. All grade adjustments of manhole frame and cover assemblies shall be completed utilizing one of the following:

1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and be free from cracks, voids and other defects. Concrete rings will be set with asphalt mastic.

2. High Density Polyethylene Grade Adjustment Rings: Comply with ASTM D 1248 for recycled plastic.

   a. Material properties shall be tested and certified for usage by the following ASTM methods:

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g / 10 min.
Density	ASTM D 792	0.94 to 0.98 g / cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 lb / in^2

   b. Polyethylene adjusting rings shall not be used when they are exposed to heated hot mix asphalt pavement.
   c. Tapered configuration: When used in a single configuration tapered adjusting ring thickness will range from 0.5 inch to 3.0 inch.
   d. Grade adjustment rings are to be installed on clean flat surfaces according to the manufacturer's recommendations with the proper Butyl Rubber sealant/adhesives.

B. The inside diameter of the adjustment ring shall not be less than the inside diameter of the manhole frame.

C. Manholes shall be constructed with at least two adjustment rings.

D. Maximum height of adjustment ring stack: 12 inches max. for new manholes and 16 inches max. on existing manholes.

2.03 CASTINGS (Ring and Cover)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Sanitary Sewer Manhole Ring and Covers:

1. Refer to Plans for locations of types.

2. Machined bearing surfaces.

3. All covers must be gasketed.

4. Grassed areas not subject to flooding: Type A.

5. Grassed areas subject to flooding, bolted down cover: Type C.

6. Paved areas, sidewalks, and areas subject to vehicular traffic and not subject to flooding or in sloped paved areas use cover: Type B.

7. Paved areas, sidewalks, and areas subject to vehicular traffic and flooding or in sloped paved areas subject to flooding, use bolted down cover: Type D.

2.04 CHIMNEY SEAL (Required on all Sanitary Sewer Manholes)

A. External Seal:

1. Rubber Sleeve and Extension:
   a. Corrugated, minimum thickness of 3/16 inches, per ASTM C 923.
   b. Minimum vertical unexpanded length of 6 and 9 inches with allowable vertical expansion of at least 2 inches.
   c. Top section of sleeve shall contain multiple sealing fins to extend both over and under the manhole frame's base flange. Bottom section of sleeve shall contain an integrally formed compression band recess with multiple slaking fins.
   d. Top section of extension to be shaped to fit into the bottom band recess of the sleeve. Bottom section of extension shall contain an integrally formed compression band recess with multiple sealing fins.

2. Compression Bands:
   a. One piece band assembly to compress sleeve or extension against manhole surface.
   b. Material 16 gauge ASTM A 240 Type 304 stainless steel, minimum 1 inch width, minimum adjustment range of 4 diameter inch.
   c. Top band shaped to lock sleeve to manhole frame's base flange.
   d. Stainless steel fasteners, ASTM F 593 and 594, Type 304.

B. Internal Seal:

1. Rubber sleeve and extension:
   a. Double pleated, minimum thickness 3/16 inch thick, per ASTM C 923.
   b. Minimum vertical unexpanded length of 8 and 10 inches with allowable vertical expansion of at least 2 inches.
   c. Integrally formed expansion band recess top and bottom with multiple sealing fins.
   d. Top section of extension shaped to fit bottom band recess of the sleeve. Bottom section of extension shall contain an integrally formed expansion band recess with multiple sealing fins.

2. Expansion Bands:
   a. One-piece band assembly to compress sleeve or extension against manhole surfaces.
   b. Material 16 gauge ASTM A 240 Type 304 stainless steel, minimum 1 3/4 inch width, minimum adjustment range of 2 inches.
   c. Locking mechanism of studs and nuts used to be stainless steel conforming to ASTM F 923 & 594, Type 304.

2.05 INVERT: Poured in place concrete. Shape to provide a smooth transition between pipe inverts. Bring manhole invert up to one half of pipe diameter to produce a half pipe shape. Slope invert bench toward pipe 1/4 inch per foot perpendicular to flow line.

PART 3 - EXECUTION

3.01 MANHOLE INSTALLATION

A. Manhole Chimney

1. Install internal or external rubber chimney seal in accordance with Section 6020, 3.04.

2. Aromatic Flexible Urethane Seal:

a. Surface Preparation shall be in accordance with the manufacturer's recommendations and shall include sandblasting, pressure washing, sealing leaks or gaps, and drying surface.
b. Apply primer, prepare product and apply in accordance with manufacturer's recommendations.

B. Subgrade Preparation:

1. Undisturbed soil: Hand grade to accurate elevation.

2. Disturbed soil: Machine compact to 95 percent of Standard Proctor Density and hand grade to accurate elevation or install stabilization material as directed by Engineer.

C. Installation of Poured In Place Base: Sanitary sewers: embed base riser in base slab 3 inches, minimum. Assure proper vertical and horizontal alignment of base riser section.

D. Installation of Precast Base with Base Riser: Assure proper vertical and horizontal alignment of base riser section.

E. Additional Risers: Install additional riser sections as required. Grout inside face of joints.

F. Repair: Repair any honeycomb areas or damaged areas as directed by Engineer.

G. Backfill up to pipe grades. Connect and bed pipes using bedding material up to one foot above top of pipes.

H. Sanitary sewers: Grout inside pipe/manhole joint. Install rubber plug and grout over manhole lift holes.

I. Install manhole invert. Remove any projections and repair any voids to assure a hydraulically smooth channel between pipe ends.

J. Install manhole top slab or cone.

K. Install manhole adjustment rings. Bed each ring with cold-applied bituminous jointing compound. Do not install more than total ring stack height of 12 inches. For greater adjustment, modify barrel riser section(s).

L. Install manhole ring and cover. Adjust accurately to proper grade. Where manhole is to be in a paved area, adjust slope to match finished surface.

M. Install chimney seal: Install chimney seal per manufacturer's recommendations on sanitary sewer manholes.

N. Seal Manhole Joints: Apply bituminous joint compound or butyl sealant wrap to exterior of sanitary sewer manholes joints.

O. Backfill and compact. Refer to Section 2322. Use extra care to assure proper and uniform compaction of backfill around structure.

3.02 MODIFICATION OF EXISTING MANHOLES

A. Minor Adjustment: adjustment by adding or removing adjusting rings:

1. Add adjustment rings if necessary, up to a total ring stack height of 16 inches to adjust existing manhole to finished pavement grade or finished topsoil grade. Bed each ring with cold applied bituminous jointing material.

2. Remove one or more adjustment rings, as appropriate to reduce casting elevation.

3. Replace castings. Install new frame and cover for manholes located within new full depth pavement: use adjustable frame and cover as specified.

4. Replace chimney seal for sanitary sewer manholes using only new materials.

5. Refer to Section 2751 and 2741 for additional manhole adjustment requirements in pavement.

B. Major Adjustment: adjustment by adding or removing barrel or cone sections

1. Remove castings.

2. Remove top.

3. Modify barrel riser or modify type of top section, as appropriate, or both.

4. Replace castings. Install new frame and cover for manholes located within new full depth pavement. Use an adjustable frame and cover as specified.

5. Replace chimney seal for sanitary sewer manholes using only new materials.

C. Connection to Existing Manhole: Unless otherwise specified in the contract documents, or approved by the Engineer, all new openings in existing manholes shall be cored.

1. Excavate as appropriate. Mark manhole barrel for point of insertion of added sewer line.

2. Divert flow as necessary. Maintain sewer service at all times unless otherwise permitted by Engineer.

3. Carefully cut and chip or core out opening to manhole. Remove existing manhole invert as necessary to install pipe at required elevation and develop hydraulic channel.

4. Cored opening:
   a. Insert flexible watertight connector into new opening.
   b. Install and tighten internal expansion sleeve to hold flexible connector in place.
   c. Insert pipe through flexible connector and tighten external compression ring.
   d. Do not grout opening or pour collar for cored opening with flexible connector.

5. Cut and chipped opening (knockout): When allowed, refer to Figure 6020.21
   a. Install waterstop around outside of pipe. Secure in place.
   b. Position end of pipe flush with interior wall of manhole and with waterstop located within wall opening.
   c. Grout opening between manhole wall and outside of pipe with non-shrink grout.
   d. Pour concrete collar around pipe and exterior manhole opening.

6. Reconstruct manhole invert.

7. Bed pipe and backfill per Section 2322.

3.03 CHIMNEY SEALS (Required on All Sanitary Sewer Manholes)

A. Install internal chimney seal if manhole is to be under pavement or, if not under pavement, is set more than 3 inches above final grade or subject to movement.

B. Install external chimney seal if manhole is not to be under pavement except as noted in 3.04 A.

C. Install seals on a smooth sealing surface. Seals to extend from the flange of the manhole frame to 3 inches below the adjusting ring, use multiple seals, if necessary. Install compression bands (external chimney seal) or expansion bands (internal chimney seal) to lock the rubber sleeve or extension into place and to provide a positive watertight seal. Once tightened lock into place. Use only manufacturer recommended installation tools and sealants.

3.04 ABANDONED MANHOLES

A. Remove top and walls of structure to a minimum of 10 feet below subgrade in paved areas or 10 feet below finish grade in other areas.

B. Plug all pipes in structure using 3,000 psi concrete.

C. Fill remaining structure using flowable mortar.

D. Place compacted earth fill over structure as required for embankment or compacted backfill.

END OF SECTION

SECTION 33 40 00

STORM SEWER AND DRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Storm Sewers.

B. Subdrains.

C. Footing Drain Sewer Collectors.

D. Storm Sewer Service.

1.02 DESCRIPTION OF WORK

A. Construct storm sewers, subdrains, and footing drain collectors.

B. Construct storm sewer service and connections.

C. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2012, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Manufacturer′s instructions for installation of pipe and appurtenances.

C. Construction sequence.

D. Catalog cuts, samples, manufacturer′s data, and listing of applicable standards for special, unique, or proposed substitute materials if requested by Engineer.

E. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.

F. Project Record Documents.

G. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store materials and handle to avoid damage. Replace any damaged materials. Remove damaged materials from site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:
1. Attend a preconstruction meeting if required by Engineer.
2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations, and verify clearance for proposed construction.
2. Complete elements of work that can affect line and grade in advance of storm sewer construction unless noted on plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state and federal requirements.

1.08 MEASUREMENT FOR PAYMENT

A. All measurements for payments will be made by the Engineer or authorized representative.

B. Storm Sewers and Subdrains:
1. Measurement of pipe, except aprons, will be in linear feet along centerline of pipe in place.
2. Measurement of each size and type of pipe installed will be from end of pipe to end of pipe.
3. Payment will be made at the unit bid price for each size and type installed.

C. Incidental Items:
1. Items that are not listed as specific bid items, but are required for proper completion of the work, are incidental to construction. Pipe testing is incidental.
2. Incidental items may or may not be shown on plans.
3. No payment shall be made for incidental items.

PART 2 - PRODUCTS

2.01 STORM SEWERS

A. Reinforced Concrete Pipe (RCP):
1. Conform to ASTM C 76.
2. Minimum Class III, Wall B.
3. Tongue and groove joints.
   a. Use cold applied bituminous jointing materials, unless otherwise specified.
   b. If specified, use rubber O-ring flexible joint conforming to ASTM C 443.
4. If specified, wrap exterior of each joint with engineering fabric.

E. Polyvinyl Chloride Pipe (PVC):
1. Use pipe conforming to the following:
   a. Minimum pipe stiffness of 46 psi.
   b. ASTM F 949, corrugated exterior, smooth interior; ASTM D 3034, solid wall PVC; ASTM F 679, solid wall PVC (up to 27 inches).
   c. Gasketed integral bell and spigot joints per ASTM D 3212 and ASTM F 477.

2. Do not use in right-of-way.
3. Use only outside of right-of-way in public utility easement areas where no utilities exist or are proposed (running parallel or crossing) or where the trench for the PVC pipe will not be disturbed, and where the Engineer allows.

F. High Density Polyethylene (HDPE): N-12 PIPE: PIPE SHALL BE ADS N-12 MEGA GREEN.
1. Pipe shall consist of smooth interior and annular exterior corrugations.
2. 4- through 10-inch (100 to 250 mm) shall meet ASTM F2648(virgin/recycled material) , Type S.
3. 12- through 60-inch (300 to 1500 mm) shall meet ASTM F2648 (virgin/recycled resins), Type S.
2. Use only fittings supplied or recommended by pipe manufacturer for soil tight service.
3. Only use outside of Public Right of Way where allowed by jurisdiction.

G. Bituminous Jointing Material:
1. Use with RCP, RCAP, and RCEP, unless indicated otherwise on plans.
2. Use a cold applied mastic sewer joint sealing compound recommended by the manufacturer for the intended use and approved by the Engineer. Supply in either rope form or flat type form or suitable for trowel application. Meet the requirements of AASHTO M 198.

H. Bituminous Joint Primer: Meet the requirements of ASTM D 41, which is intended for use in priming concrete pipe joints prior to application of bituminous jointing material.

I. Engineering Fabric**:**
1. Use for wrapping exterior of storm sewer pipe joints where indicated on plans.
2. Use Iowa DOT 4196.01B fabric for use in subsurface drains.

J. Reinforced Concrete Apron:
1. Use where indicated on plans.
2. Use pipe conforming to ASTM C 76.
3. Strength not less than adjoining pipe sections.

K. Apron Guard:
1. Use where indicated on plans.

2.02 SUBDRAINS

A. Polyvinyl Chloride Pipe and Fittings (Solid Wall PVC):
1. Conform to ASTM D 3034, minimum thickness SDR 35, 46 psi minimum pipe stiffness.
2. PVC plastic according to ASTM D 1784, Cell Classification 12454.
3. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.
4. Fabricated or preformed saddle wye or saddle tee for service tap conforming to AASHTO M 252 or M 294.
5. Slot subdrain pipe according to ASTM F 949 or perforate with four rows of 1/4 inch to 3/8 inch diameter holes along the bottom of the pipe.

B. Polyvinyl Chloride Corrugated Pipe and Fittings (Corrugated PVC):
1. Corrugated exterior, smooth interior, PVC.
2. Conform to ASTM F 949, minimum pipe stiffness, 46 psi.
3. PVC plastic according to ASTM D 1784, Cell Classification 12454.
4. Integral bell and spigot type rubber gasket joint conforming to ASTM D 3212 and ASTM F 477.
5. Slot subdrain pipe according to ASTM F 949.

C. Polyethylene Corrugated Tubing (Corrugated PE):

1. Conform to AASHTO M 252, Type C, corrugated interior and exterior or Type S, corrugated exterior, smooth interior.
2. Use only fittings supplied or recommended by pipe manufacturer for soil tight service.
3. Perforated with slots conforming to AASHTO M 252, Type CP, or Type SP.

D. Aggregate Backfill: Conform to State of Iowa Department of Transportation Standard 4131, Porous Backfill Material; Crushed stone or gravel meeting Iowa DOT Gradation No.29.

E. Engineering Fabric: Use fabric conforming to Iowa DOT 4196.01B.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify measurements at site; make necessary field measurements to accurately determine pipe makeup lengths or closures.

B. Examine site conditions to ensure construction operations do not pose hazards to adjacent structures or facilities.

3.02 LINE AND GRADE

A. Install pipe to line and grade shown on plans. Set field grades to invert of pipes or culverts.

B. Notify Engineer immediately if discrepancies or irregularities are discovered in line or grade shown by grade stakes.

C. Make detailed measurements as required to construct work to line and grade established by line and grade hubs.

D. Batter Boards:
1. Set grade points at 25-feet intervals at convenient offset from centerline of pipe or culvert.
2. Set batter boards as necessary to construct to design line and grade.
3. Provide at least three batter boards at all pipe laying areas during construction as check on accuracy of grades.
4. Check line and grade of each pipe length with grade rod and plumb bob.

E. Laser Beam:
1. Set laser equipment to proper line and grade from line and grade hubs.
2. Check line and grade of laser at 25-feet intervals for first 100 feet and then at 50-feet intervals for each setup.
3. Check line and grade of each pipe length.

F. Correct Misalignment: Correct misalignment, displacement, or otherwise defective pipe by removing, relaying, or replacing pipe at Contractor′s expense.

3.03 PIPE INSTALLATION

A. Provide trench excavation, pipe bedding, and backfill as specified in Section 31 23 33.

B. Provide proper facilities for lowering the sections into place without damaging the pipe.

C. Begin at lowest point in line. Lay groove or bell end point upstream unless specifically noted otherwise.

D. Prepare trench bottom to design line and grade so only minor movement of pipe is necessary after installation.

E. Inspect pipe for defects before carefully lowering into trench. Do not install damaged or defective pipe.

F. Clean pipe interior and joints prior to lowering into trench. Keep pipe clean during construction.

G. Do not lay pipe in water or on saturated soil or bedding. Do not allow water to rise in trench around pipe.

H. Place pipe with lifting holes at the top of the pipe and fill lift hole with non-shrink grout or manufactured plugs.

I. Lay pipe to design line and grade.

J. Provide uniform bearing for full pipe barrel length.
1. Excavate bell holes as necessary for uniform support of pipe barrel on bedding material.
2. Do not block pipe above bedding.

K. Assemble joints as specified.

L. Protect exposed upstream ends of pipe to prevent soil sediment from entering storm sewer system with the watertight stopper, cap, or plug.

M. Do not disturb installed pipe and bedding when using movable trench boxes and shields. Block or anchor pipe as necessary to prevent joint displacement.

N. Saw cut ends of pipe at manholes, intakes, and structures. Do not hammer cut or break pipe.

O. Provide manholes and intakes where indicated on plans and as specified.

3.04 PIPE JOINTING

A. Joint Cleaning: Clean joint surfaces with wire brush to remove soil or foreign material prior to jointing pipe.

B. Assemble Joints According to Pipe Manufacturer's Recommendations:
1. Use equipment that does not apply damaging forces to pipe joints.
2. Use bar and block or internal or external jointing devices or other methods recommended by pipe manufacturers.

C. RCP, RCAP, and RCEP:
1. Use cold applied bituminous jointing materials unless otherwise specified.
   a. Apply joint material to entire tongue or to top half of tongue and bottom half of groove, in sufficient quantity to fill joint; close joint between pipes.
   b. Fill remaining voids in joint both inside and outside of pipe with joint material; smooth joint material on inside of pipe 24 inches and larger.
2. If rubber O ring is specified, coat rubber ring gasket and joint with soap-based lubricant immediately prior to closing joint.
3. If wrapped pipe joint is specified,
   a. Secure engineering fabric in place to prevent displacement during backfill operations.
   b. For combination storm sewer/subdrain or Type II subdrain, do not use joint sealant.
4. Joint openings on the outside or inside of the pipe that do not exceed 1/8 inch at the bottom and 5/8 inch at the top are acceptable.

5. Fully encase large joint openings, unless required for camber, with a Type II concrete collar (see Figure 4020.1A). Use Class C structural concrete.

D. RCPP: Coat rubber ring gasket and joint with soap-based lubricant immediately prior to closing joint.

E. CMP and CMAP:
1. Install coupling bands that match ends of pipes.
2. End of coupling bands must lap or be fabricated to form tightly closed joint upon installation.

F. PVC Pipe and Corrugated PVC Pipe: Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.

G. High Density Polyethylene (HDPE): Coat rubber gasket and joint with soap-based lubricant immediately prior to closing joint.

H. High Density Polyethylene (HDPE): N-12 MONSTER GREEN PIPE:
1. Fittings shall conform to ASTM F2648.
2. Joints shall be N12 ST IB (Soil Tight)
   a. Join pipes with bell & spigot joint meeting ATSM F2648.
   b. Soil Tight gaskets shall meet the requirements of ASTM F477.
   c. Gaskets shall be installed by pipe manufacturer and covered with removable wrap to ensure gasket is free of debris.
   d. Joint lubricant available from manufacture shall be used on the gasket and bell during assembly

I. Connections between Dissimilar Pipes:
1. Use manufactured adapters or couplings approved by Engineer.
2. Where adapters or couplings are not available, Engineer may authorize use of concrete collar.

3.05 PIPE END SECTIONS

A. Provide reinforced concrete or metal pipe aprons where indicated on plans.

B. Install footings with aprons according to figure, if required.

C. Anchor last three pipe sections and aprons together with two pipe connections per joint.

D. Install apron guard where indicated on plans.

3.06 SUBDRAINS AND TRENCH DRAINS

A. Provide subdrain where indicated on plans.

B. Provide trench drains where indicated on plans.

C. If specified, install engineering fabric.

3.07 FOOTING DRAIN COLLECTOR

A. Install footing drain collector per Section 31 23 33.

B. If specified, install engineering fabric.

C. Provide cleanouts and connections.

1. Connect footing drain sewer collectors to storm sewer manhole or intake.
2. Provide fabricated or preformed wye or tee service fitting for each platted lot or building.

D. Provide manholes, if specified.

3.08 STORM SEWER SERVICE STUBS

A. Provide storm sewer service connection and line from storm sewer or footing drain sewer for each platted lot or building as shown on plans.

B. Use fabricated or preformed saddle wye or saddle tee for service tap to storm sewers. Clamp with two stainless steel clamps and install according to the manufacturer′s recommendations.

C. Extend storm sewer service from storm sewer or footing drain collector to 10 feet outside of the right-of-way line or as shown on the plans.

D. Place watertight stopper or plug in end of storm sewer service.

3.09 TOLERANCES

A. Horizontal and vertical alignment of gravity sewer lines shall not vary from design line and grade at any point along the pipe by more than 1% of the inside diameter of the pipe or 1/4 inch, whichever is larger.

B. Tolerance allowed only if design line and grade is sufficient to prevent backslope when tolerance limits are reached.

C. Reverse slope on pipe is prohibited.

3.10 CONFLICTS

A. Provide temporary support for existing water, gas, telephone, power, and other utilities or services that cross trench.

B. Compact backfill under existing utility crossing as specified in 3123 33 or construct utility line supports where indicated on plans or as directed by Engineer.

3.11 STORM SEWER ABANDONMENT

A. When sewers are to be abandoned, standard sewer plugs shall be placed. Prior to placing the plug, ensure the line is not in use. If noted on the plans, fill the line with gravity flow or pump the line full of flowable mortar or controlled low strength material.

3.12 CLEANING

A. Clean all storm sewers by flushing with water and by removing sheeting, bracing, shoring, forms, soil sediment, concrete, or other debris as directed by Engineer prior to final acceptance.

B. Do not discharge soil sediment or debris to drainage channels or existing storm sewer or sanitary sewer systems.

PART 4 - TESTING

4.01 DESCRIPTION OF WORK

A. Test and inspect storm sewers, culverts, footing drain sewers and building storm sewers.

4.02 SCHEDULING

A. Notify Owner's Representative when installation is complete and ready for testing.

B. Notify Owner's Representative at least 24 hours prior to performing testing.

C. Owner's Representative must be present to review testing procedures and to record results.

4.03 TESTING EQUIPMENT

A. Conform with applicable sections of ASTM.

B. Conform to other applicable industry standards and codes.

4.04 VISUAL INSPECTION

A. Check each section of storm sewer by lamping.

B. Light should be visible through section of pipe lamped.

C. Visually inspect each section of pipe.

D. Repair or replace defective pipe or joints or remove and relay pipe not meeting alignment tolerances as directed by Engineer.

4.05 DEFLECTION TESTING

A. Perform deflection tests on all HDPE storm sewer pipe 12" diameter or greater.

B. Perform deflection tests after backfill has been in place at least 30 days and before paving activity takes place or as per appropriate sections of these specifications.

C. Pipe deflection shall not exceed 5% of average inside diameter as established by ASTM Standards.

D. Pull approved 9-arm deflection mandrel through sewer by hand.

E. Approved mandrel must conform to applicable ASTM Standards.

F. Remove and replace pipe exceeding deflection limits.

G. Handle and divert existing flows during deflection testing.

END OF SECTION

SECTION 33 49 00

STORM DRAINAGE STRUCTURES

SUBPARTS:

A. MANHOLES
B. INTAKES
C. CAST-IN-PLACE
D. NYPLOPLAST INTAKE SUBSTITUTES

A. MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manholes for storm sewers.

B. Adjustment of existing manholes.

C. Connection to existing manholes.

D. Abandonment of manholes.

1.02 DESCRIPTION OF WORK

A. Construct storm sewer manholes, modify existing manholes, and abandon manholes where shown in the Plans.

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings showing compliance with this Specification.

C. Shop drawing schedule of new manholes showing total depth, relative elevations of all connecting sanitary or storm sewer lines, all drops, and orientation of connecting lines.

D. Catalog cuts of iron castings and sewer line connection gaskets.

E. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

C. Precast sections meeting the requirements of ASTM C 478.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:
1. Attend a preconstruction meeting if required by Engineer.
2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
2. Complete elements of the work which can affect line and grade in advance of other open cut construction unless noted on plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and Federal requirements.

C. Storm Sewer Manholes:
1. Manhole Types:

Type	Description	Main Pipe Size	Typical Depth	Figure No.
SW-401	48" Min. Dia. Short Cone or Flat Top with Poured or Precast Base	See Table 1 for Max. Dia. Pipe	7' Min.	6010.401
SW-402	Precast or Poured-in-Place Box with Precast or Poured-in-Place Base	24" or Greater	8' Max.	6010.402
SW-403	Poured-in-Place Box with Poured-in-Place Base	12" Dia. or Greater	6' - 12'	6010.403
SW-404	Combination 48" Dia. Short Cone with Poured-in-Place Barrel and Poured-in-Place Base	12" Dia. or Greater	12' - 22'	6010.404
SW-405	48" Dia. Short Cone with T-Section	42" Dia. or Greater eccentric reducer required for 42"	8.5' Min.	6010.405

2. Ring and Cover Types:

Type	Ring & Cover	No. of Pieces	Bolted Frame	Bolt Cover	Gasketed	Figure No.
E*	Standard	2	Yes	No	No	
F**	Adjustable	3	No	No	No	
G*	Machined Bearing Surfaces	2	No	No	No	

***** Use when placed in earth fill, asphalt pavement, or ACC manhole boxout.
** Use when placed in PCC pavement or PCC manhole boxout.

1.08 MEASUREMENT FOR PAYMENT

A. All measurements for payments will be made by the Engineer or authorized representative.

B. Manhole: For each type and size of manhole required and furnished, measure manhole vertical dimension in feet from the flow line to the top of the ring casting. Payment shall be at the unit bid price for each type and size of manhole properly installed. The unit bid price for manholes shall include all bedding, backfill, compaction and all appurtenances including castings and lids necessary for the proper installation.

PART 2 PRODUCTS

2.01 MANHOLES

A. Placement: Conform to elevations, locations and connection orientations shown on the Plans and detailed drawings.

B. Barrel Diameter, Inside: For sewers up to 24-inch size with two connections use 48 inches diameter barrel or as shown in the contract documents. For larger sewers or more connections, see Plans and detailed drawings.

C. Wall Thickness: See Detailed plans and Iowa SUDAS plans.

D. Top Configuration: Eccentric top except as noted on the Plans or detailed drawings. Total manhole depth 6 feet or more use cone top section. Total manhole depth less than 6 feet use minimum 9" thick flat top.

F. Joints, Barrel: Male and female ends with Mastic seal

G. Concrete: Precast: Comply with ASTM C 478. Cast in place: Refer to Cast-In-Place Storm Sewer Structure Section.

H. Base: Precast manhole: Separate base from riser section; use with precast base or poured base. Cast in place manhole: Use with precast base or poured base.

I. Pipe Connection:
   1. New Storm Sewer Manhole:
      a. Precast manholes: factory fabricated openings.
      b. Poured in place structures: structure wall poured around pipe stub.
   2. Existing Storm Sewer Manhole:
      a. Cored or drilled opening: Provide a flexible, watertight connection that meets and/or exceeds ASTM C 923.
      b. Knock out opening:
         1) Provide a watertight connection (waterstop or other method), meeting the material requirements of ASTM C 923, that is securely attached to the pipe with stainless steel bands or other means.
         2) Grout opening in manhole wall with non-shrink grout.
         3) Pour concrete collar around pipe and outside manhole opening.
         4) Provide flexible pipe joint or flexible connector within 2' of collar.

J. Manhole Steps: None, unless required on the Plans. If required, space steps at 12 to 16 inches, comply with ASTM C 478. Align with vertical side of eccentric cone top section.

2.02 MANHOLE ADJUSTMENT RINGS (Grade rings)

A. All grade adjustments of manhole frame and cover assemblies shall be completed utilizing one of the following:
   1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and be free from cracks, voids and other defects. Concrete rings will be set with asphalt mastic.
   2. High Density Polyethylene Grade Adjustment Rings: Comply with ASTM D 1248 for recycled plastic.
      a. Material properties shall be tested and certified for usage by the following ASTM methods:

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g / 10 min.
Density	ASTM D 792	0.94 to 0.98 g / cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 lb / in^2

b. Polyethylene adjusting rings shall not be used when they are exposed to heated hot mix asphalt pavement.
c. Tapered configuration: When used in a single configuration tapered adjusting ring thickness will range from 0.5 inch to 3.0 inch.
d. Grade adjustment rings are to be installed on clean flat surfaces according to the manufacturer's recommendations with the proper Butyl Rubber sealant/adhesives.

B. The inside diameter of the adjustment ring shall not be less than the inside diameter of the manhole frame.

C. Manholes shall be constructed with at least two adjustment rings.

D. Maximum height of adjustment ring stack: 12 inches max. for new manholes and 16 inches max. on existing manholes.

2.03 CASTINGS (Ring and Cover)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Storm Sewer Manhole Ring and Covers:
1. Grassed areas: Type E.
2. Paved areas, sidewalks, areas subject to vehicular traffic and sloped surfaces: Type F.
3. For installation directly into concrete pipe riser manhole, Type G.
4. Bolt all castings set above grade.
5. Storm sewer manhole lids shall not be bolted.

2.04 CEMENT MORTAR - Refer to Cast-In-Place Storm Sewer Structure Section.

2.05 REINFORCING STEEL - Refer to Cast-In-Place Storm Sewer Structure Section.

2.06 INVERT:

A. Poured in place concrete. Shape to provide a smooth transition between pipe inverts. Bring manhole invert up to one half of pipe diameter to produce a half pipe shape. Slope invert bench toward pipe 1/4 inch per foot perpendicular to flow line.

PART 3 - EXECUTION

3.01 MANHOLE INSTALLATION

A. Subgrade Preparation:
1. Undisturbed soil: Hand grade to accurate elevation.
2. Disturbed soil: Machine compact to 95 percent of Standard Proctor Density and hand grade to accurate elevation or install stabilization material as directed by Engineer.

B. Installation of Poured In Place Base: Bed base riser section in Class C concrete. Assure proper vertical and horizontal alignment of base riser section.

C. Installation of Precast Base with Base Riser: Assure proper vertical and horizontal alignment of base riser section.

D. Additional Risers: Install additional riser sections as required. Grout inside face of joints.

E. Repair: Repair any honeycomb areas or damaged areas as directed by Engineer.

F. Backfill up to pipe grades. Connect and bed pipes using bedding material up to one foot above top of pipes.

G. Install manhole invert. Remove any projections and repair any voids to assure a hydraulically smooth channel between pipe ends.

H. Install manhole top slab or cone.

I. Install manhole adjustment rings. Bed each ring with cold-applied bituminous jointing compound. Do not install more than total ring stack height of 12 inches. For greater adjustment, modify barrel riser section(s).

J. Install manhole ring and cover. Adjust accurately to proper grade. Where manhole is to be in a paved area, adjust slope to match finished surface.

K. Backfill and compact. Refer to Section 31 23 33. Use extra care to assure proper and uniform compaction of backfill around structure.

3.02 MANHOLE TESTING - Refer to Section 33 40 00.

B. INTAKES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Intakes for storm sewers.

B. Special structures for storm sewers.

1.02 DESCRIPTION OF WORK

A. Construct intakes and special structures for storm sewers.

B. Modify existing intakes

C. Abandon intakes.

D. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings showing compliance with this Specification.

C. Schedule of new intakes showing total depth, and relative elevations and orientations of all connecting storm sewer lines.

D. Catalog cuts of iron castings.

E. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications or for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

1.06 SCHEDULING AND CONFLICTS

A. Construction Sequence:
   1. Attend a preconstruction meeting if required by Engineer.
   2. Submit plan for construction sequence and schedule prior to commencing construction.

B. Conflict Avoidance:
   1. Expose possible conflicts in advance of construction, such as utility lines and drainage structures. Verify elevations and locations of each and verify clearance for proposed construction.
   2. Complete elements of the work which can affect line and grade in advance of other open cut construction unless noted on plans.
   3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown or changed conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and Federal requirements.

1.08 MEASUREMENT FOR PAYMENT

A. All measurements for payments will be made by the Engineer or authorized representative.

B. Intake: Measure the number of all properly completed intakes. Payment shall be at the unit bid price for each size and type, and shall include all bedding, backfill, compaction, grates and appurtenances for proper installation.

C. Intake Adjustment: Count each item as a completed individual unit, as identified in the Bid Schedule. Payment shall be at the unit bid price for each adjustment as per plan.

D. Special Structure: Count each item as a completed individual unit, as identified in the Bid Schedule.

PART 2 - PRODUCTS

2.01 INTAKES

A. Conform to elevations, locations and connection orientations shown on the Plans.

B. Intake type; Refer to Plans.

C. Configuration and Dimensions; Refer to Detailed Drawings.

D. Top Configuration:
1. As noted on Detailed Drawings.
2. Number of grate sections; Refer to Plans.

E. Joints, Wall:
1. Precast; Male and female ends, mastic seal.
2. Poured in place; construction joints.

F. Concrete:
1. Precast: Precast concrete intakes constructed in accordance with the requirements of following Cast In Place Section, and with the dimensions and reinforcement shown in standard detailed drawings.
2. Cast in place;
   a. Refer to following Cast-In-Place Section.
   b. Minimum concrete reinforcing cover 2 inches.
   c. Minimum total section thickness; see Standard Detailed Drawings.

G. Base:
1. Separate. Use with base riser section with square bottom edge.
2. Precast may have surface finish block outs on one side only.

H. Pipe Connection:
1. Precast intake; factory fabricated openings.
2. Poured in place structures; structure wall poured around pipe stub.

I. Manhole Steps: None, unless required on the Plans. If required, space steps at 12 to 16 inches, comply with ASTM C 478.

2.02 INTAKE ADJUSTMENT RINGS (Grade rings)

A. All grade adjustments of intake frame and cover assemblies shall be completed utilizing one of the following:
1. Reinforced Concrete Grade Adjustment Rings: Comply with ASTM C 478 and be free from cracks, voids and other defects. Concrete rings will be set with asphalt mastic.
2. High Density Polyethylene Grade Adjustment Rings: Comply with ASTM D 1248 for recycled plastic.
   a. Material properties shall be tested and certified for usage by the following ASTM methods:

Property	Test Method	Acceptable Value
Melt Flow Index	ASTM D 1238	0.3 to 30 g/10 min.
Density	ASTM D 792	0.94 to 0.98 g/cm^3
Tensile Strength	ASTM D 638	2.00 to 5 x 10^3 lb/in^2

b. Polyethylene adjusting rings shall not be used when they are exposed to heated hot mix asphalt pavement.
c. Tapered configuration: When used in a single configuration tapered adjusting ring thickness will range from 0.5 inch to 3.0 inch.
d. Grade adjustment rings are to be installed on clean flat surfaces according to the manufacturer's recommendations with the proper Butyl Rubber sealant/adhesives.

B. The inside dimension of the adjustment ring shall not be less than the inside dimension of the intake grate opening.

C. Intakes shall be constructed with at least two adjustment rings.

D. Maximum height of adjustment ring stack: 12 inches for new and existing intakes.

2.03 CASTINGS (Covers and Grates)

A. Gray Cast Iron: ASTM A 48, Class 35.

B. Type: Refer to Detailed Drawings and Plans.

2.04 CEMENT MORTAR - Refer to following Cast In Place Section.

2.05 REINFORCING STEEL - Refer to following Cast In Place Section.

2.06 INVERT

A. Poured in place concrete. Establish a full seal between base and base riser section.

B. Shape to provide a smooth transition between pipe inverts.

C. Bring intake invert up to one half of pipe diameter to produce a half pipe shape.

PART 3 EXECUTION

3.01 INTAKE INSTALLATION

A. Subgrade Preparation:
1. Undisturbed soil: Hand grade to accurate elevation.
2. Disturbed soil: Machine compact to 95 percent of Standard Proctor Density and hand grade to accurate elevation, or install Stabilization Material as directed by Engineer.
3. Unstable soil: Install Stabilization Material as directed by Engineer.

B. Concrete Intakes:
1. Install Stabilization Material if unstable base exists.
2. Install Granular Bedding Material if required by Detailed Drawings.
3. Install base; assure proper vertical and horizontal alignment of base riser section.
4. Install additional riser section as required. Seal all joints.
5. Repair any honeycomb areas or damaged areas.
6. Compact backfill up to connecting pipes.
7. Connect and bed pipes per Section 3010. Grout inside pipe/riser joint.
8. Install intake invert. Remove any projections and repair any voids to assure a hydraulically smooth channel through intake.
9. Install top.
10. Install adjustment rings. Install at least two rings. Bed each ring with cold-applied bituminous jointing compound. Do not install more than total ring stack height of 12 inches. For greater adjustment, modify riser section(s).
11. Install top casting. Adjust accurately to proper line and grade.

12. Backfill and compact. Refer to Section 3010. Use extra care to assure proper and uniform compaction of backfill around structure.

C. Anchoring Castings: All castings not encased in concrete shall be bolted down.

3.02 CONCRETE, REINFORCEMENT, AND PLACEMENT. Refer to Cast In Place Section.

3.03 SPECIAL STRUCTURES

A. Construct in accordance with this Section, as applicable.

B. Refer to Plans for locations, dimensions and special details and provisions.

3.04 ABANDONED INTAKES

A. Remove entire structure to a minimum of 10 feet below subgrade in paved areas or 6 feet below finish grade in other areas.

B. Plug all pipes in structure.

C. Fill remaining structure using flowable mortar.

D. Place compacted earth fill over structure as required for embankment or compacted backfill.

C. CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural Portland cement concrete and reinforcing for manholes and intakes for sanitary and storm sewer systems, and other structures such as concrete thrust blocks and sewage air release pits as designated by the Engineer.

1.02 DESCRIPTION OF WORK

A. Construct Portland cement concrete structures for sanitary and storm sewers.

B. Reference is made to the Iowa Department of Transportation Standard Specifications for Highway and Bridge Construction, Series 2001, and all current General Supplemental Specifications and Materials Instructional Memorandum by the term "Iowa DOT Specifications" and/or "Iowa DOT I.M."

1.03 SUBMITTALS

A. Submit under provisions of Division 1.

B. Shop drawings of steel reinforcement, showing sizes, lengths, bends, and counts, if required.

C. Concrete mix design, if required by Engineer.

D. Sample test results and certifications.

E. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.

F. Project Record Documents.

G. Upon requests the Contractor will provide Material Certifications to the Engineer.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications and for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Store reinforcing steel only on pallets or lagging. Replace any damaged materials. Remove damaged materials from the site.

C. Aggregate storage and concrete transport shall follow Section 7010, 1.05.

1.06 SCHEDULING

A. Construction Sequence:
   1. Schedule concrete placement to coordinate with other work, such that trenching, backfilling and other work can proceed in an orderly manner and to provide the greatest protection for new work.

B. Conflict Avoidance:
   1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations and verify clearance for proposed construction.
   2. Complete elements of work which can affect line and grade in advance of pipe construction unless noted on plans.
   3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and federal requirements.

C. Restrictions: Restriction on operations shall follow Section 7010, 1.07.

1.08 MEASUREMENT FOR PAYMENT

A. The cost for concrete and reinforcing in the construction of manholes and intakes for storm sewer systems, or other special structures, will not be measured separately but will be considered incidental to intakes and manholes or other concrete structures as described in this specification document, including sampling and testing.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Portland Cement:
   1. ASTM C 150, Type I or Type III when specified.
   2. Air entrained per ASTM C 260.

3. Iowa DOT Class C concrete unless otherwise specified in the contract documents.

B. Aggregates:
   1. Per ASTM C 33.
   2. Coarse and fine aggregate shall follow Section 7010, 2.02.

C. Water: Follow Section 7010 2.02 E

D. Liquid Admixtures for Portland Cement Concrete:
   1. Description
      a. Meet requirements of AASHTO M 154 for air entraining mixtures.
      b. Meet requirements of AASHTO M 194 for other liquid admixtures.
      c. Submit tests by a recognized laboratory for Engineer approval.
      d. Admixtures containing more than 1% chloride ions shall not be allowed unless approved by Engineer.
      e. Inspection and acceptance of liquid admixtures will be in accordance with Iowa DOT Materials I.M. 403
   2. Air Entraining Admixtures: Provisions shall be made to stir, agitate, or circulate air entraining admixtures prior to use to insure a uniform and homogeneous mixture.
   3. Retarding and Water Reducing Admixtures
      a. Shall be compatible with air entraining agent.
      b. Shall be introduced into the mixer after all other ingredients
      c. Agitate prior to and during use in accordance with Iowa DOT Materials I.M. 403
      d. Dosage rate shall be applied to both cement and fly ash when used.
   4. Other Admixtures: Other admixtures may be used with the approval of the Engineer in accordance with the manufacturer's recommendations.

2.02 CONCRETE QUALITY

A. Compressive Strength: Minimum 4,000 psi at 28 days.

B. Water-Cement Ratio: Follow Section 7010, 2.03.

C. Air Content: The intended air entrainment is 6.0%. To allow for loss during placement, the air content of fresh, unvibrated structural concrete shall be 6.5%, as a target value, with a maximum variation of plus or minus 1.0%.

D. Slump: Structural concrete shall be placed with a slump between 1 inch and 3 inches as a target range, allowing a maximum of 4 inches unless specifically modified by the Engineer.

E. Admixtures: Per manufacturer’s recommendations.

2.03 REINFORCEMENT

A. Reinforcing Steel:
   1. Use deformed bars.
   2. Epoxy coated deformed bars apply only when specified.
   3. Billet steel; ASTM A 615, Grade 60.
   4. Fabricate and bend, per approved submittals or Plans.
   5. Fabricate all bars prior to delivery to site unless field bends are required.

B. Wire Fabric:
   1. Per ASTM A 185.
   2. Size and mesh; as shown on Detailed Drawings or on Plans.
   3. Placement; as shown on Detailed Drawings or on Plans.
   4. Joints; lap not less than 6 inches.

2.04 CEMENT MORTAR: Mix in the following portions:

A. Portland Cement: Type I; 10 Parts

B. Mortar Sand: 20 Parts

C. Lime, Hydrated: 3/4 to 1 Part

PART 3 EXECUTION

3.01 FORMING

A. All cast in place manholes and structures shall be formed on both the inside and the outside face above the base. No earth excavation next to the proposed manhole shall be used as forming.

B. Use metal or plywood-lined forms for exposed surfaces.

C. Erect and secure forms to true line and grade.

D. Coat forms with non-staining mineral oil before placing reinforcing. Do not apply oil to surfaces to which concrete must be bonded.

E. Use 3/4 inch bevel for exposed corners, unless otherwise required.

3.02 REINFORCING STEEL

A. Remove dirt, scale and other materials that might impair concrete bond.

B. Place reinforcement where shown. Space bars properly and secure in position.

C. Reinforcement for slabs; support with chairs or bolsters. Do not use wood, bricks, stones or other foreign materials.

D. Lap bars 36 diameters, except as otherwise shown.

3.03 MIXING: (IOWA DOT 2403)

A. Provide accurate control for measuring materials.

B. Concrete, as discharged from the mixer, shall be uniform in composition and consistency. Each batch of concrete shall be thoroughly discharged from the mixer before the next batch is introduced. Upon cessation of mixing for any considerable length of tie, the mixer shall be thoroughly cleaned and flushed with water.

C. Ready-Mixed Concrete: conform to ASTM C 94.

3.04 PLACING

A. Clean and dampen forms, reinforcing steel and embedded items.

B. Prevent segregation during placement. Do not allow concrete to fall more than 4 feet from placement chute to final position.

C. Place concrete continuously in each section until complete. Do not allow more than 30 minutes between depositing adjacent layers of concrete within each section.

D. Thoroughly compact, puddle and vibrate concrete into corners and around reinforcing and

embedded items. Vibrate sufficiently to work concrete into crevices and around steel. Refer to Iowa DOT 2403.09.

E. Place sections of concrete in a sequence which eliminates the effect of shrinkage to the greatest extent practicable.

F. Concrete shall not be placed when the air temperature is less than 40 degrees Fahrenheit without the approval of the Engineer. Refer to Iowa DOT 2403.11.

3.05 FINISHING

A. Refer to Iowa DOT 2403.21.

B. Use rough form finish to areas not visible to the public.

C. Use smooth form finish for areas visible to the public.

D. Use broomed finish for slabs, except as noted on Plans or Detailed Drawings.

3.06 STRIPPING AND CLEANING

A. Remove forms for manhole and intake walls and tops according to Iowa DOT 2403.18.
1. References to culverts shall include all sanitary and storm structures.
2. When allowed by the Engineer, compressive strengths at six times the stated flexural strengths may be used in determining concrete strength of structure roofs.

B. Chip out and repair any honeycomb areas per direction of Engineer.

C. Break back form ties and fill holes with portland cement mortar.

D. Remove flashing and thin webs.

3.07 CURING

A. Refer to Iowa DOT 2403.10.

B. Apply curing system immediately after finishing or stripping of forms, as applicable.

C. Slabs on grade, visible to the public; use only curing compounds meeting ASTM C 309, Type 1-D or Type 2.

3.08 EXTERIOR LOADING

A. Restrict loads on concrete, other than the load caused by the weight of the concrete itself, according to Iowa DOT Section 2403.19.

B. When allowed by the Engineer, compressive strengths at six times the stated flexural strengths may be used.

3.09 TESTING

A. Provide required testing by a testing service approved by Engineer, unless such services are provided by Jurisdiction.

B. Review and test proposed mix design when required by Engineer.

C. Obtain production samples of job-delivered concrete mix after any needed water has been added

and the concrete remixed.

D. Mold and cure three specimens per ASTM C 31.

E. Strength Testing: Unless otherwise specified in the contract documents strength testing will be the responsibility of the Contractor by a certified testing service.
   1. Test specimens in accordance with ASTM C 39. Test one sample at 7 days for information. Test two samples at 28 days. The acceptance test results shall be the average of the compressive strength of the two specimens tested at 28 days. If one of the 28 day samples manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining sample shall be considered the test result.
   2. Make at least one strength test for each 100 cubic yards or fraction thereof, and at least one test for each structure. When the total quantity is less than 50 cubic yards the strength tests may be waived by the Engineer.

F. Slump Testing: Unless otherwise specified in the contract documents testing will be by the Engineer. Determine slump of concrete sample for each strength test and whenever consistency of concrete mix appears to vary, using ASTM C 143.

G. Air Testing: Unless otherwise specified in the contract documents testing will be by the Engineer. Determine air content of concrete sample for each strength test in accordance with either ASTM C 231, ASTM C 173, or ASTM C 138.

D. NYLOPLAST INTAKES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Nyloplast Intake substitutes for certain types of concrete Intakes and vice versa.

1.02 DESCRIPTION OF WORK

A. Nyloplast Structures are allowed to be substituted for Iowa SUDAS SW-501 and SW-512 Intakes. Nyloplast intake substitutions for SW-512 area intakes must be the same size vertical barrel and grate that is called out on plans.

B. No other concrete structures are allowed to have substitutions including other types of intakes and all manholes.

C. Nyloplast Basins can be substituted with SUDAS Pre-Cast Manholes/ Intakes. SW-512 intakes are NOT an approved substitution for Nyloplast structures.

1.03 SUBMITTALS

A. Shop drawings of Nyloplast structure prior to fabrication.

B. Certification that materials being provided meet the requirements of these specifications or that alternate materials or substitutions have received written approval of the Engineer.

C. Project Record Documents.

1.04 SUBSTITUTIONS

A. Use only materials conforming to these specifications unless permitted otherwise by Engineer.

B. Obtain written approval of Engineer for all substitutions prior to use.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver only materials that fully conform to these specifications and for which submittals have been provided to Engineer and approved for use.

B. Store and handle materials to avoid damage. Replace any damaged materials. Remove damaged materials from the site.

C. Aggregate storage shall follow Section 7010, 1.05.

1.06 SCHEDULING

A. Construction Sequence:
1. Schedule intake placement to coordinate with other work, such that trenching, backfilling and other work can proceed in an orderly manner and to provide the greatest protection for new work.

B. Conflict Avoidance:
1. Expose potential conflicts such as utility lines and drainage structures in advance of construction. Verify elevations and locations and verify clearance for proposed construction.
2. Complete elements of work which can affect line and grade in advance of pipe construction unless noted on plans.
3. Notify Engineer of conflicts discovered or changes needed to accommodate unknown conditions.

1.07 SPECIAL REQUIREMENTS

A. Stop Work: Stop work and notify Engineer immediately if contaminated soils, historical artifacts or other environmental or historic items are encountered.

B. Conform to local, state, and federal requirements.

C. Restrictions: Restriction on operations shall follow Section 7010, 1.07.

1.08 MEASUREMENT FOR PAYMENT

A. The cost for granular backfill and intake castings for storm sewer systems, or other special structures, will not be measured separately but will be considered incidental to intakes and manholes.

PART 2 PRODUCTS

2.01 MATERIALS

A. Intake:
1. PVC Stock Pipe, utilizing a thermo-molding process to reform the pipe stock to the specified configuration.
2. Drainage pipe connection stubs stall be PVC pipe stock and formed to provide watertight connection with the specified pipe system sizes and angles.
3. The raw material used to manufacture the pipe stock that is used to manufacture the main body and pipe stubs shall conform to ASTM D1784 cell class 12454.

B. Joints:
1. Joint tightness shall conform to ASTM D3212 for drain and sewer plastic pip using flexible elastomeric seals.
2. Flexible elastomeric seals shall conform to ASTM F477.
3. The pipe bell spigot sall be joined to the main body of the drain basin or catch basin.

C. SW-512 and A2000 Area Intake Grates for Nyloplast structures:
1. Grates and frames furnished for all Nyloplast intake structures shall be ductile iron and the same size as the intake stack.
2. Intake grates shall be capable of handling H-20 loads for all structures placed into paving.
All other structures shall comply with H-10 loading.
3. Metal used in manufacture of the castings shall conform to ASTM A536 grade 70-50-05 ductile iron.
4. Grates shall be natural and contain no paint.

D. SW-501 Intake Grates for Nyloplast structures:
1. The grate, frame and hood assembly shall be ductile iron.
2. The grate, frame and hood shall all be capable of supporting H-20 loading.
3. The hood section will have a solid back and be adjustable by use of three (3) hex head bolts.
4. Metal used in manufacture of the castings shall conform to ASTM A536 grade 70-50-05 ductile iron.
5. Grates shall be natural and contain no paint.

PART 3 EXECUTION

3.01 INSTALLATION

A. All intakes shall be staked by a licensed land surveyor.

B. Intakes shall be placed in accordance with stakes provided by surveyor. In the event of a discrepancy between stakes and plans, contractor shall contact engineer and/ or land surveyor prior to intake placement.

C. Granular backfill for base and intakes shall comply with manufacture recommendations. All backfill material shall conform with IOWA SUDAS backfill specifications for concrete intakes. Sand in NOT a permitted backfill material and backfill shall be Class 2 material defined in ASTM D2321.

D. Intakes shall be designed and placed approximately 12” over height. Upon completion of final grading, Intakes shall be cut to the grade as specified on the approved construction plans. If intake stack is either manufactured too short or cut too short in the field, intake shall be completely replaced at contractor/ manufacture’s expense.

E. All intakes installed in paved areas (H-20 loaded structures), a concrete ring shall be poured under and around the grate and frame. The concrete slab must be designed for local soil conditions, traffic loading, among any other applicable design factors.

F. For any other installation considerations such as migration of fines, ground water and soft foundations, refer to ASTM D2321 guidelines.

END OF SECTION