

PROJECT MANUAL

(VOLUME 2 of 2) (DIV 21 – DIV 32, AND APPENDIX)

PROJECT NAME:

DOE ISD Girls Dormitory Repairs

DEPARTMENT OF EDUCATION (DOE)

IOWA SCHOOL FOR THE DEAF (ISD)

PROJECT ADDRESS:

Iowa School for the Deaf
3501 Harry Langdon Blvd
Council Bluffs, Iowa 51503



PROJECT DATE: August 14, 2024

OWNER:

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



OWNER PROJECT NUMBER: 9356.00

OWNER REQUEST FOR BID NUMBER: RFB 935600-01

CONSTRUCTION MANAGER:

Samuels Group
2929 Westown Parkway, Suite 200
West Des Moines, Iowa 50266



CONSTRUCTION MANAGER PROJECT NUMBER: 7665

ARCHITECT:

HGM Associates
640 Fifth Avenue
Council Bluffs, Iowa 51501



ARCHITECT PROJECT NUMBER: 105023A

(VOLUME 2 of 2) (DIV 21 – DIV 32 AND APPENDIX)

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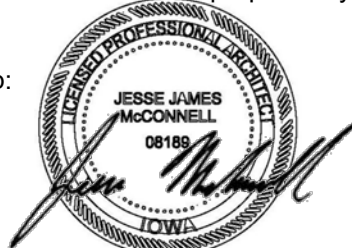
SECTION 00 0107

SEALS PAGE

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and responsible charge.

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Responsibility: *All Divisions except Division 21 – Fire Suppression; Division 22 – Plumbing; Division 23 – HVAC; Division 26 – Electrical; Division 28 – Electronic Safety And Security.*

I hereby certify that the portion of this technical submission described below was prepared by me or under my direct supervision and responsible charge.

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Responsibility: *Division 26 – Electrical; Division 28 – Electronic Safety And Security.*

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Responsibility: *Division 21 – Fire Suppression; Division 22 – Plumbing; Division 23 – HVAC.*

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GENERAL FIRE SUPPRESSION PROVISIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The work required under the Fire Suppression Contract shall include all material, labor, equipment and services necessary and reasonably incidental to the proper completion of the systems, and all special work as hereinafter specified and indicated on the drawings.
- B. All work shall be executed in such a manner as to interfere as little as possible with the normal functioning of the facility, including operations of all utility services and any equipment, and with work being done by others. Roads shall be kept clear of materials, etc., at all times so that there will be no interference with the usual traffic. Where necessary, on account of new work connecting to existing pipes, where utility services are required to be cut, they shall be cut and capped at suitable places where indicated by drawings, or in the absence of such indication, where directed by the Architect/Engineer. No road traffic or utility service such as water, gas, or steam shall be interrupted without prior approval of the Owner, and all arrangements for work which will involve such interference shall be made in advance with the Owner so that same can be effected in a minimum of time and interference.

1.2 RELATED SECTIONS

- A. See Front End Specifications for General Requirements.
- B. See Front End Specifications for General Conditions: Performance bond and labor and material payment bonds, warranty, and correction of work.
- C. See Front End Specifications for Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- D. See Front End Specifications for Execution and Closeout Requirements: Contract closeout procedures.
- E. Individual Product Sections: Specific requirements for operation and maintenance data.
- F. Individual Product Sections: Warranties required for specific products or Work.

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. Drawings and specifications shall be taken together. Provide work specified and not indicated, or work indicated and not specified as though mentioned in both. The final drawings to be submitted to the Authorities Having Jurisdiction shall be designed by a licensed fire sprinkler contractor under the supervision of a licensed Fire Protection Engineer to the applicable NFPA standards and all governing rules, regulations, codes, ordinances, or laws. The design documents and specifications indicate major system components, routing requirements, and performance requirements and are to be used as guidelines for the compilation of final submitted drawings.
- B. In case of discrepancy between drawings and specifications, or within either document, the greater quantity of work and/or better quality shall be used for estimating and the matter brought to the Architect/Engineer's attention for a written decision.

- C. Drawings are to be interpreted as diagrammatic only, 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. It should be understood that the Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining these locations. Contractor shall refer to the Architectural drawing for dimensions of walls, foundations, structural beams, and other structural building members. 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.
- D. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where such items are required by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.
- E. 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.
- F. Where words "provide", "install", or "furnished" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and connect up complete and ready for operation, the items mentioned.

1.4 COOPERATION AND PROGRESS

- A. Keep informed about the work of all other trades engaged in the project and execute the work in such a manner as not to delay or interfere with the progress of other contractors. This contractor shall schedule his work so that no other contractor is delayed in the execution of his work. Complete cooperation of all trades is expected. Employ a competent foreman on job throughout the entire project to ensure that coordination is maintained.
- B. Schedule and coordinate the work of this Division with the schedule of the contractor to progress the work expeditiously, and to avoid unnecessary delays.
- C. Examine fully the drawings and specifications for other contractors for other trades, and coordinate the installation of this work with the work of the other contractors. Consult and cooperate with other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment, and the building. The Owner's representative reserves the right to determine space priority in the event of interference between piping, conduit, ducts, and equipment of the various contractors.
- D. Conflicts between the drawings and the specification shall be called to the attention of the Owner's representative and Architect/Engineer. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the contractor is in agreement with the drawings and specifications as issued. If clarification is required after the Contract is awarded, such clarification will be made by the Architect/Engineer and his decision will be final.
- E. Coordinate the installation of all fire suppression system components with all other trades, including structural components and electrical trades. Allocate space in the different areas to allow for the installation of ductwork, piping, sprinklers, waste and vents, and mechanical equipment above ceilings and in equipment spaces. Recommend rerouting, resizing or relocation of mechanical components, if necessary, so all trades can install their systems in the space allotted.
- F. After award of the Contract, and prior to start of construction, the General Contractor shall schedule a meeting with the contractor and all subcontractors responsible of the work items listed above. The purpose of the meeting is to introduce the coordination program and to determine its implementation in relation to the progress schedule.

- G. All contractors and subcontractors shall participate in the coordination process. Participation is mandatory. If a contractor or subcontractor fails to participate in the coordination process, the Owner reserves the right to do the following:
1. Stop any and all construction progress payments for any work performed by the contractor. Such payments will be reinstated only after the contractor or subcontractor resumes participation in the coordination drawing process.
 2. Relocate and resize contractor's work components as necessary to ensure all components will be installed as intended. In the event the contractor did not participate in the coordination process, he will not be entitled to any contract cost increases or time extensions due to Owner initiated changes in the work.
- H. The contractor shall also be held responsible for any unnecessary rework by other trade contractors that is attributable to his failure to participate in the coordination process.
- I. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility because of the scale of the drawings. Each contractor is expected to have included in his bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process. The contractor will not be allowed any contract cost extra or time extension for changes dictated by the coordination process.
- J. Utility installation in congested areas is dependent on the sequence of utility installation as much as it is dependent on the physical size of the utilities. The contractors shall use the coordination process to properly sequence the installation of utilities as appropriate to ensure the above ceiling and congested area utility installation is satisfactory.

1.5 GUARANTEE

- A. The Contractor, by the acceptance of this specification and the signing of the Contract, acknowledges his acquaintance with all the requirements and guarantees that every part going to make up the system, will be the best of its respective kind and will be erected in a most thorough and substantial manner by none but experienced labor.
- B. The Contractor guarantees that all piping as provided in this specification will be free from all obstructions, and that all piping will be tight and drip free.
- C. The Contractor shall have a licensed Fire Protection Engineer on staff responsible for the design and installation of the fire suppression system(s). The Contractor shall guarantee design and installation is in compliance with all rules, regulations, codes, ordinances, or laws of the Authorities Having Jurisdiction.
- D. The Contractor guarantees that all equipment and appliances will successfully and acceptably perform the work for which they are installed and that each will operate smoothly and quietly up to its rated capacity.
- E. The Contractor further guarantees himself responsible for any defects which may develop in any part of the system, including equipment, piping, and sprinkler heads, due to faulty workmanship, design or material; and to replace and make good, without cost to the Owner, any such faulty parts or construction which develop defects at any time within one (1) year from the date of substantial completion. The date of substantial completion shall be as defined in the Contract Documents. Any repairs or replacement required on account of defects, as outlined in this paragraph shall be made promptly upon written notice from the Architect.
- F. Natural wear, accident, or carelessness on the part of others, however, shall not be made good by the Contractor.

1.6 PROTECTION OF INSTALLED WORK AND MATERIAL STORED ON SITE

- A. The Contractor is responsible for all work installed by him until his contract is complete and shall protect it from injury by others.
- B. All piping, fittings, equipment and material to be stored on the jobsite for any period of time shall be protected from the weather in a manner that is acceptable to the Architect.

1.7 SITE VISIT

- A. Bidders are advised to visit the site and inform themselves as to all conditions, and failure to do so will in no way relieve the successful bidder from the necessity of furnishing any material or performing any work that may be required to complete the work in accordance with the true intent and meaning of the drawings and specifications without additional cost to the Owner.
- B. Before bidding the job, investigate, determine and verify locations and invert elevations of sanitary and storm sewers, city water mains and any other buried or overhead utilities on or near site. Determine such locations in conjunction with all public and private utility companies and with all authorities having jurisdiction.
- C. On projects where remodeling of an existing structure is in the scope of the project, the contractor shall field verify locations of existing piping and ductwork. The contractor shall verify the exact locations of existing piping to which the new piping is to connect and if the locations of the existing piping is different than that shown on the drawings, the contractor shall include the additional cost in his bid proposal. The contractor shall also field verify the locations of existing piping that is in conflict with the routing of the new work, and include in his bid proposal monies for the rerouting of the existing work in order to accommodate the new work.

1.8 RULES, REGULATIONS AND CODES

- A. The Contractor shall become acquainted with the local codes, and in case of a discrepancy between plans or specifications and the local codes, the Contractor shall use the code requirements. The greater quantity of work and material and/or better quality shall be used for estimating and the matter brought to the Architect's attention for a written decision.
- B. Perform all work in strict accordance with all rules, regulations, codes, ordinances, or laws of Local, State, and Federal governments, or of other authorities having lawful jurisdiction. Comply therewith. Such rules, regulations, codes, ordinances, or laws include, but are not necessarily limited to, the following:
 - 1. State building and fire codes.
 - 2. State plumbing and mechanical codes.
 - 3. City building and fire codes.
 - 4. City plumbing and mechanical codes.
 - 5. American Gas Association.
 - 6. National Electric Code.
 - 7. National Fire Protection Association.
 - 8. Occupation Safety and Health Act.
- C. If the Contractor notes, at the time of bidding, any parts of the plans and specifications which are not in accord 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 his proposal a separate price required to make the system shown on the drawings comply with the codes and regulations.

- D. 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.

1.9 SUBSTITUTIONS

- A. The Architect/Engineer shall be the sole and final judge as to the suitability of items substituted for those specified.
- B. The entire cost of all changes of any type due to substitutions for materials specified shall be borne by the Contractor at no extra cost to the Owner.
- C. Unsolicited and voluntary deducts, on the part of the Contractor for substituting unapproved equipment, shall not be considered for the purpose of awarding the Contract.
- D. When the drawings and/or specifications refer to any item, article, material, method, fabrication, assembly or construction by means of one or more manufacturer's trade name, catalog reference or similar means of identification of manufacturer, the Contractor shall furnish one of the makes so identified without substitution unless other make or makes have been approved by addendum to the contract documents prior to the receipt of bids. Requests for the approval of items of equal quality are requested to be made in writing to the Architect/Engineer five days prior to the date of the receipt of bids so that a list of acceptable equal quality items can be made known to all bidders by an addendum. If substitution for names items, articles, materials, methods, fabrications, assembly or construction are approved, the Contractor assumes all responsibility for coordination and performing the related changes in the work necessitated by such substitutions and shall include in his bid all costs involved therein.

1.10 SHOP DRAWING REVIEW

- A. The Contractor shall be responsible for designing and installing the fire suppression system(s) to the applicable NFPA standard and all rules, regulations, codes, ordinances, or laws as required by the Authorities Having Jurisdiction. The submitted shop drawings shall include the professional engineering seal of the responsible fire protection engineer with copies provided to the Architect/Engineer and the local authorities having jurisdiction including the Fire Marshal for review and approval.
- B. Shop drawings will be reviewed only to extent of information indicated. This check is only for review of general conformance with the design concept of the project and general compliance with the information given the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes techniques of construction, coordinating his work in a safe and satisfactory manner.
- C. Review of shop drawings shall not relieve Contractor of responsibility for providing all controls, wiring, components, etc., which are shown or specified, or all additional controls, wiring, components, etc., required to provide complete and correctly operating mechanical systems.
- D. In cases where substituted equipment has been installed in place of specified equipment the Contractor shall bear the entire cost of all changes of any type due to the substitution, even though the shop drawings have been reviewed by the Architect/Engineer.
- E. Shop drawings in no way relieve the contractor from performing on the job as to the intent of the construction documents.

1.11 CONNECTING NEW WORK TO EXISTING WORK

- A. Connect new work to existing work in a neat workmanlike manner. In every case where any part of the existing work must be cut to install new work, or is damaged, same must be patched and repaired in a manner satisfactory to the Architect. Where relocation of existing equipment and piping systems is necessary in areas providing uninterruptible services, schedule work during slack periods. Anticipate scheduling work at a period which will result in additional construction cost, such as overtime for work to be done at night or on weekends. Include cost in the bid proposal.
- B. Do not cut into existing services without first informing the Owners representative as to the time and duration of shutdown of the existing services.
- C. Perform work that interrupts any service at a time that will cause least interference to the operation of the building.
- D. Maintain all existing services and equipment unless indicated to be removed.

1.12 ACCESS TO EQUIPMENT FOR MAINTENANCE

- A. Install all equipment, piping, etc., to permit access for normal maintenance. Maintain easy access to motors, valves, etc. Install all such equipment and accessories to facilitate maintenance. Perform any relocation of pipes, ducts, etc. required to permit access at request of Architect/Engineer at no additional cost to Owner.

1.13 FIRE AND SMOKE STOPPAGE

- A. It shall be the responsibility of this Contractor to maintain and fire and smoke integrity of all walls, ceilings, floors, etc., through which this work passes through or into. Fire and smoke barriers shall be provided in and around as required by Codes.
- B. Where holes are required to be patched, or conduit, piping, ducts, etc., are required to be patched around, it shall be filled with a material that is UL Classified Standard 1479 for this use and Factory Mutual System approved.
- C. Fire and smoke stoppage material shall be water based with intumescent properties. Material may be in the form of caulking, putty pads or wrap strips. Materials shall be installed in accordance to manufacturers and UL standards.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION- NOT USED

END OF SECTION 210050

SECTION 210500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Above ground piping.
- B. Buried piping.
- C. Escutcheons.
- D. Expansions - hose and braid.
- E. Mechanical couplings.
- F. Pipe sleeves.
- G. Pipe sleeve-seal systems.

1.2 RELATED REQUIREMENTS

- A. Section 210523 - General-Duty Valves for Water-Based Fire-Suppression Piping.
- B. Section 211200 - Fire-Suppression Standpipes: Standpipe design.
- C. Section 211300 - Fire-Suppression Sprinkler Systems: Sprinkler systems design.

1.3 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information. Indicate valve data and ratings.
- C. Shop Drawings: Indicate pipe materials used, jointing methods, supports, and floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.4 QUALITY ASSURANCE

- A. Comply with FM (AG) and UL (DIR) requirements.
- B. Valves: Bear FM (AG) and UL (DIR) product listing label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- C. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.6 WARRANTY

- A. See Front End Specifications and Section 210501 for closeout submittal procedures.
- B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Sprinkler-based System:
 - 1. Comply with NFPA 13.
 - 2. See Section 211300.
- B. Standpipe and Hose System:
 - 1. Comply with NFPA 14.
 - 2. See Section 211200.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX.
- D. Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.2 BURIED PIPING

- A. Ductile Iron Pipe: AWWA C151/A21.51.
 - 1. Fittings: AWWA C110/A21.10, standard thickness.
 - 2. Joints: AWWA C111/A21.11, styrene-butadiene rubber (SBR) or vulcanized SBR gasket.
 - 3. Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

2.3 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A53 Schedule 40 or ASTM A795 Schedule 40, black.
 - 1. Steel Fittings: ASME B16.5 steel flanges and fittings.
 - 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings and ASME B16.4, threaded fittings.
 - 3. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
 - 4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
 - 5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

- B. CPVC Pipe: ASTM F442/F442M, SDR 13.5.
 - 1. Fittings: ASTM F438 Schedule 40, or ASTM F439 Schedule 80, CPVC.
 - 2. Joints: Solvent welded, using ASTM F493 cement.

2.4 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
- B. Plastic, Sheet Metal, or Moisture-Resistant Fiber: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C. Pipe Passing Through Below Grade Exterior Walls:
 - 1. Zinc-coated or cast-iron pipe.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- D. Not required for wall hydrants for fire department connections or in drywall construction.
- E. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
 - 3. Rated Openings: Caulked tight with firestopping material complying with ASTM E814 in accordance with architectural firestopping requirements to prevent the spread of fire, smoke, and gases.

2.5 PIPE SLEEVE-SEAL SYSTEMS

- A. Modular Mechanical Seals:
 - 1. Elastomer-based interlocking links to continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
 - 2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
 - 3. Size and select seal component materials in accordance with service requirements.
 - 4. Service Requirements:
 - a. Corrosion resistant.
 - b. Underground, buried, and wet conditions.
 - c. Fire Resistance: 1 hour, UL (DIR) approved.
 - 5. Glass-reinforced plastic pressure end plates.
- B. Wall Sleeve: Steel material with waterstop collar, and nailer end caps.
- C. Sleeve-Forming Disk: Nonconductive plastic-based material, 3 inch thick.
- D. Pipeline-Casing Seals:
 - 1. End Seals: 1/8 inch, pull-on type, rubber or synthetic rubber based.

2.6 ESCUTCHEONS

- A. Material:
 - 1. Metals and Finish: Comply with ASME A112.18.1.
- B. Construction:
 - 1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
 - 2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.7 PIPE HANGERS AND SUPPORTS

- A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
- B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
- C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
- E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
- F. Vertical Support: Steel riser clamp.
- G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- H. Seismic Hangers and Couplings:
 - 1. Provide coupling with a factory set disengagement rating of 140 percent to 160 percent of the static weight.
 - 2. Provide resettable and reusable, break away couplings.
 - 3. Provide tether cables to avoid excessive seismic joint movement.
 - 4. Coupling to be manufactured from non-corrosive materials.

2.8 EXPANSION JOINTS AND LOOPS - HOSE AND BRAID

- A. Provide flexible loops with two flexible sections of hose and braid, two 90-degree elbows, and 180-degree return with support bracket and air release or drain plug.
- B. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.
- C. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 - 1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
 - 2. End Connections: Same as specified for pipe jointing.
 - 3. Provide necessary accessories including, but not limited to, swivel joints.

2.9 MECHANICAL COUPLINGS

A. Rigid Mechanical Couplings for Grooved Joints:

1. Dimensions and Testing: Comply with AWWA C606.
2. Minimum Working Pressure: 300 psig.
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B. Install standpipe piping, hangers, and supports in accordance with NFPA 14.
- C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- D. Install piping to conserve building space, to not interfere with use of space and other work.
- E. Install CPVC piping only where hidden above a ceiling or in a wall and where allowed by NFPA 13. No CPVC piping shall be exposed.
- F. Group piping whenever practical at common elevations.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- H. Inserts:
 1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- I. Pipe Hangers and Supports:
 1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 2. Place hangers within 12 inches of each horizontal elbow.
 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- L. Do not penetrate building structural members unless indicated.
- M. Provide sleeves when penetrating floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- N. Manufactured Sleeve-Seal Systems:
 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a watertight seal.
 6. Install in accordance with manufacturer's recommendations.
- O. Escutcheons:
 1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
 2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
 3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.
- P. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- Q. Provide gate valves for shut-off or isolating service. Install valves with stems upright or horizontal.
- R. Provide drain valves at main shut-off valves and low points of piping and apparatus.

END OF SECTION 210500

SECTION 211300

FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System design, installation, and certification.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. FM (AG) - FM Approval Guide.
- B. UL (DIR) - Online Certifications Directory.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturer's catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Shop Drawings:
 - 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 - 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
 - 3. Submit shop drawings to Authorities Having Jurisdiction for approval. Submit proof of approval to Engineer/Engineer.
- D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
- E. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
 - 2. Sprinkler Wrenches: For each sprinkler type.
- G. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.5 QUALITY ASSURANCE

- A. Comply with FM (AG) requirements.
- B. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- C. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience and approved by manufacturer.
- D. Equipment and Components: Provide products that bear FM (AG) label or marking.
- E. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.7 EXTRA MATERIALS

- A. Provide extra sprinklers of type and size matching those installed, in quantity required by reference NFPA design and installation standard.
- B. Provide suitable wrenches for each sprinkler type.
- C. Provide metal storage cabinet located adjacent to alarm valve.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Sprinklers, Valves, and Equipment:
 - 1. Anvil International
 - 2. Tyco Fire Protection Products
 - 3. Viking Corporation
 - 4. Reliable Sprinkler
 - 5. Victaulic Company

2.2 SPRINKLER SYSTEM

- A. Sprinkler System: Provide coverage for entire building.
- B. Occupancy: Refer to 3.03 SCHEDULES section.
- C. Water Supply: Determine volume and pressure from water flow test data.
- D. Interface system with building fire and smoke alarm system.
- E. Provide fire department connections where indicated.

- F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.3 SPRINKLERS

- A. Suspended Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
1. Response Type: Quick.
 2. Finish: Enamel, color white .
 3. Escutcheon Plate Finish: Enamel, color white.
 4. Fusible Link: Glass bulb type temperature rated for specific area hazard.
- B. Finished Gypsum Board Ceiling Type: Semi-recessed pendant type with matching push on escutcheon plate.
1. Response Type: Quick.
 2. Finish: Enamel, color as selected.
 3. Fusible Link: Glass bulb type temperature rated for specific area hazard.
- C. Exposed Area Type: Upright type.
1. Response Type: Quick.
 2. Finish: Brass.
 3. Fusible Link: Glass bulb type temperature rated for specific area hazard.
- D. Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
1. Response Type: Quick.
 2. Finish: Brass.
 3. Escutcheon Plate Finish: Brass.
 4. Fusible Link: Glass bulb type temperature rated for specific area hazard.
- E. Guards: Finish to match sprinkler finish.
- F. Flexible Drop System: Stainless steel, multiple use, open gate type.
1. Application: Use to properly locate sprinkler heads.
 2. Include all supports and bracing.
 3. Provide braided type tube as required for the application.
 4. Manufacturers:
 - a. FlexHead Industries, a brand of Anvil International
 - b. Victaulic Company; Vic-Flex

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with referenced NFPA design and installation standard.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Install buried shut-off valves in valve box. Provide post indicator.

- D. Place pipe runs to minimize obstruction to other work.
- E. Place piping in concealed spaces above finished ceilings.
- F. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.
- G. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- H. Flush entire piping system of foreign matter.
- I. Install guards on sprinklers in storage rooms and mechanical and electrical equipment rooms and data closets.
- J. Provide 250 deg. F sprinkler heads in mechanical and electrical equipment rooms and data closets.
- K. Hydrostatically test entire system.

3.2 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system.

3.3 SCHEDULES

- A. System Hazard Areas:
 - 1. Scope of work anticipates relocating fire sprinkler heads and piping only as required to install new HVAC services. Match existing space classification.

END OF SECTION 211300

SECTION 220050

GENERAL PLUMBING PROVISIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The work required under Plumbing Contract shall include all material, labor, equipment and services necessary and reasonably incidental to the proper completion of the systems, and all special work as hereinafter specified and indicated on the drawings.
- B. All work shall be executed in such a manner as to interfere as little as possible with the normal functioning of the facility, including operations of all utility services and any equipment, and with work being done by others. Roads shall be kept clear of materials, etc., at all times so that there will be no interference with the usual traffic. Where necessary, on account of new work connecting to existing pipes, where utility services are required to be cut, they shall be cut and capped at suitable places where indicated by drawings, or in the absence of such indication, where directed by the Architect/Engineer. No road traffic or utility service such as water, gas, or steam shall be interrupted without prior approval of the Owner, and all arrangements for work which will involve such interference shall be made in advance with the Owner so that same can be effected in a minimum of time and interference.

1.2 RELATED SECTIONS

- A. See Front End Specifications for General Requirements.
- B. See Front End Specifications for General Conditions: Performance bond and labor and material payment bonds, warranty, and correction of work.
- C. See Front End Specifications for Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- D. See Front End Specifications for Execution and Closeout Requirements: Contract closeout procedures.
- E. Individual Product Sections: Specific requirements for operation and maintenance data.
- F. Individual Product Sections: Warranties required for specific products or Work.

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. Drawings and specifications shall be taken together. Provide work specified and not indicated, or work indicated and not specified as though mentioned in both.
- B. In case of discrepancy between drawings and specifications, or within either document, the greater quantity of work and/or better quality shall be used for estimating and the matter brought to the Architect/Engineer's attention for a written decision.

- C. Drawings are to be interpreted as diagrammatic only, 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. It should be understood that the Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining these locations. Contractor shall refer to the Architectural drawing for dimensions of walls, foundations, structural beams, and other structural building members. 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.
- D. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where such items are required by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.
- E. 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.
- F. Where words "provide", "install", or "furnished" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and connect up complete and ready for operation, the items mentioned.

1.4 COOPERATION AND PROGRESS

- A. Keep informed about the work of all other trades engaged in the project and execute the work in such a manner as not to delay or interfere with the progress of other contractors. This contractor shall schedule his work so that no other contractor is delayed in the execution of his work. Complete cooperation of all trades is expected. Employ a competent foreman on job throughout the entire project to ensure that coordination is maintained.
- B. Schedule and coordinate the work of this Division with the schedule of the contractor to progress the work expeditiously, and to avoid unnecessary delays.
- C. Examine fully the drawings and specifications for other contractors for other trades, and coordinate the installation of this work with the work of the other contractors. Consult and cooperate with other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment, and the building. The Owner's representative reserves the right to determine space priority in the event of interference between piping, conduit, ducts, and equipment of the various contractors.
- D. Conflicts between the drawings and the specification shall be called to the attention of the Owner's representative and Architect/Engineer. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the contractor is in agreement with the drawings and specifications as issued. If clarification is required after the Contract is awarded, such clarification will be made by the Architect/Engineer and his decision will be final.

- E. Coordinate the installation of all mechanical system components with all other trades, including structural components and electrical trades. Allocate space in the different areas to allow for the installation of ductwork, piping, sprinklers, waste and vents, and mechanical equipment above ceilings and in equipment spaces. Recommend rerouting, resizing or relocation of mechanical components, if necessary, so all trades can install their systems in the space allotted. Any proposed changes from the systems layout, on the drawings, shall be done in accordance with the design criteria specified in the applicable codes and shall be subject to the review and acceptance of the Architect/Engineer.
- F. After award of the Contract, and prior to start of construction, the General Contractor shall schedule a meeting with the contractor and all subcontractors responsible of the work items listed above. The purpose of the meeting is to introduce the coordination program and to determine its implementation in relation to the progress schedule.
- G. All contractors and subcontractors shall participate in the coordination process. Participation is mandatory. If a contractor or subcontractor fails to participate in the coordination process, the Owner reserves the right to do the following:
 - 1. Stop any and all construction progress payments for any work performed by the contractor. Such payments will be reinstated only after the contractor or subcontractor resumes participation in the coordination drawing process.
 - 2. Relocate and resize contractor's work components as necessary to ensure all components will be installed as intended. In the event the contractor did not participate in the coordination process, he will not be entitled to any contract cost increases or time extensions due to Owner initiated changes in the work.
- H. The contractor shall also be held responsible for any unnecessary rework by other trade contractors that is attributable to his failure to participate in the coordination process.
- I. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility because of the scale of the drawings. Each contractor is expected to have included in his bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process. The contractor will not be allowed any contract cost extra or time extension for changes dictated by the coordination process.
- J. Utility installation in congested areas is dependent on the sequence of utility installation as much as it is dependent on the physical size of the utilities. The contractors shall use the coordination process to properly sequence the installation of utilities as appropriate to ensure the above ceiling and congested area utility installation is satisfactory.

1.5 GUARANTEE

- A. The Contractor, by the acceptance of this specification and the signing of the Contract, acknowledges his acquaintance with all the requirements and guarantees that every part going to make up the system, will be the best of its respective kind and will be erected in a most thorough and substantial manner by none but experienced labor.
- B. The Contractor guarantees that all piping as provided in this specification will be free from all obstructions, and that all piping will be tight and drip free.
- C. The Contractor guarantees that, in the entire domestic water system, a continuous and noiseless circulation of water will be established to all fixtures; and that water may be drawn from any fixture without hammering.

- D. The Contractor guarantees that all equipment and appliances will successfully and acceptably perform the work for which they are installed and that each will operate smoothly and quietly up to its rated capacity.
- E. The Contractor further guarantees himself responsible for any defects which may develop in any part of the system, including equipment, piping, fixtures and appliances, due to faulty workmanship, design or material; and to replace and make good, without cost to the Owner, any such faulty parts or construction which develop defects at any time within one (1) year from the date of substantial completion. The date of substantial completion shall be as defined in the Contract Documents. Any repairs or replacement required on account of defects, as outlined in this paragraph shall be made promptly upon written notice from the Architect.
- F. Natural wear, accident, or carelessness on the part of others, however, shall not be made good by the Contractor.

1.6 PROTECTION OF INSTALLED WORK AND MATERIAL STORED ON SITE

- A. The Contractor is responsible for all work installed by him until his contract is complete and shall protect it from injury by others.
- B. All piping, fittings, equipment and material to be stored on the jobsite for any period of time shall be protected from the weather in a manner that is acceptable to the Architect.

1.7 SITE VISIT

- A. Bidders are advised to visit the site and inform themselves as to all conditions, and failure to do so will in no way relieve the successful bidder from the necessity of furnishing any material or performing any work that may be required to complete the work in accordance with the true intent and meaning of the drawings and specifications without additional cost to the Owner.
- B. Before bidding the job, investigate, determine and verify locations and invert elevations of sanitary and storm sewers, city water mains and any other buried or overhead utilities on or near site. Determine such locations in conjunction with all public and private utility companies and with all authorities having jurisdiction.
- C. On projects where remodeling of an existing structure is in the scope of the project, the contractor shall field verify locations of existing piping and ductwork. The contractor shall verify the exact locations of existing piping and ductwork to which the new ductwork and new piping are to connect and if the locations of the existing piping and ductwork are different than that shown on the drawings, the contractor shall include the additional cost in his bid proposal. The contractor shall also field verify the locations of existing piping and ductwork that are in conflict with the routing of the new work, and include in his bid proposal monies for the rerouting of the existing work in order to accommodate the new work.

1.8 RULES, REGULATIONS AND CODES

- A. The Contractor shall become acquainted with the local codes, and in case of a discrepancy between plans or specifications and the local codes, the Contractor shall use the code requirements. The greater quantity of work and material and/or better quality shall be used for estimating and the matter brought to the Architect's attention for a written decision.
- B. Perform all work in strict accordance with all rules, regulations, codes, ordinances, or laws of Local, State, and Federal governments, or of other authorities having lawful jurisdiction. Comply therewith. Such rules, regulations, codes, ordinances, or laws include, but are not necessarily limited to, the following:

1. State building and fire codes.
 2. State plumbing and mechanical codes.
 3. City building and fire codes.
 4. City plumbing and mechanical codes.
 5. American Gas Association.
 6. National Electric Code.
 7. National Fire Protection Association.
 8. Occupation Safety and Health Act.
- C. If the Contractor notes, at the time of bidding, any parts of the plans and specifications which are not in accord 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 his proposal a separate price required to make the system shown on the drawings comply with the codes and regulations.
- D. 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.

1.9 SUBSTITUTIONS

- A. The Architect/Engineer shall be the sole and final judge as to the suitability of items substituted for those specified.
- B. The entire cost of all changes of any type due to substitutions for materials specified shall be borne by the Contractor at no extra cost to the Owner.
- C. Unsolicited and voluntary deducts, on the part of the Contractor for substituting unapproved equipment, shall not be considered for the purpose of awarding the Contract.
- D. When the drawings and/or specifications refer to any item, article, material, method, fabrication, assembly or construction by means of one or more manufacturer's trade name, catalog reference or similar means of identification of manufacturer, the Contractor shall furnish one of the makes so identified without substitution unless other make or makes have been approved by addendum to the contract documents prior to the receipt of bids. Requests for the approval of items of equal quality are requested to be made in writing to the Architect/Engineer five days prior to the date of the receipt of bids so that a list of acceptable equal quality items can be made known to all bidders by an addendum. If substitution for names items, articles, materials, methods, fabrications, assembly or construction are approved, the Contractor assumes all responsibility for coordination and performing the related changes in the work necessitated by such substitutions and shall include in his bid all costs involved therein.

1.10 SHOP DRAWING REVIEW

- A. Shop drawings will be reviewed only to extent of information indicated. This check is only for review of general conformance with the design concept of the project and general compliance with the information given the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes techniques of construction, coordinating his work in a safe and satisfactory manner.
- B. Review of shop drawings shall not relieve Contractor of responsibility for providing all controls, wiring, components, etc., which are shown or specified, or all additional controls, wiring, components, etc., required to provide complete and correctly operating mechanical systems.

- C. In cases where substituted equipment has been installed in place of specified equipment the Contractor shall bear the entire cost of all changes of any type due to the substitution, even though the shop drawings have been reviewed by the Architect/Engineer.
- D. Shop drawings in no way relieve the contractor from performing on the job as to the intent of the construction documents.

1.11 CONNECTING NEW WORK TO EXISTING WORK

- A. Connect new work to existing work in a neat workmanlike manner. In every case where any part of the existing work must be cut to install new work, or is damaged, same must be patched and repaired in a manner satisfactory to the Architect. Where relocation of existing equipment and piping systems is necessary in areas providing uninterruptible services, schedule work during slack periods. Anticipate scheduling work at a period which will result in additional construction cost, such as overtime for work to be done at night or on weekends. Include cost in the bid proposal.
- B. Do not cut into existing services without first informing the Owners representative as to the time and duration of shutdown of the existing services.
- C. Perform work that interrupts any service at a time that will cause least interference to the operation of the building.
- D. Maintain all existing services and equipment unless indicated to be removed.

1.12 ACCESS TO EQUIPMENT FOR MAINTENANCE

- A. Install all equipment, piping, etc., to permit access for normal maintenance. Maintain easy access to filters, motors, drive compressors, coils, etc. Install all such equipment and accessories to facilitate maintenance. Perform any relocation of pipes, ducts, etc. required to permit access at request of Architect/Engineer at no additional cost to Owner.

1.13 FIRE AND SMOKE STOPPAGE

- A. It shall be the responsibility of this Contractor to maintained and fire and smoke integrity of all walls, ceilings, floors, etc., through which this work passes through or into. Fire and smoke barriers shall be provided in and around as required by Codes.
- B. Where holes are required to be patched, or conduit, piping, ducts, etc., are required to be patched around, it shall be filled with a material that is UL Classified Standard 1479 for this use and Factory Mutual System approved.
- C. Fire and smoke stoppage material shall be water based with intumescent properties. Material may be in the form of caulking, putty pads or wrap strips. Materials shall be installed in accordance to manufacturers and UL standards.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION- NOT USED

END OF SECTION 220050

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe supports, guides, shields, and saddles.
- B. Pipe rollers and roller supports.
- C. Pipe hangers.
- D. Strut systems for pipe or equipment support.
- E. Prefabricated trapeze-framed systems.
- F. Anchors and fasteners.

1.2 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- H. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- I. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- J. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- K. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

- L. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- M. FM (AG) - FM Approval Guide.
- N. MFMA-4 - Metal Framing Standards Publication.
- O. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- P. UL (DIR) - Online Certifications Directory.
- Q. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - 1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 QUALITY ASSURANCE

- A. Comply with applicable building code.

PART 2 PRODUCTS

1. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.
 2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
 3. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
 4. FM (AG) listed: Pipe sizes 2-1/2 to 8 inch.
 5. UL (DIR) listed: Pipe sizes 2-1/2 to 8 inch.
 6. Standard-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.
 7. Light-Duty: MSS SP-58 type 1, zinc-colored, epoxy plated.
 8. MSS SP-58 type 7 or 9, zinc-plated ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
 9. Threaded zinc-plated steel unless otherwise indicated.
- B. Hanger Rods:
1. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.
 2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
 3. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.
 4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 5. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 - a. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - b. Indoor Dry Locations: Use zinc-plated steel or galvanized steel.
 6. Strut Channel or Bracket Material:
 7. MFMA-4 compliant, pre-fabricated, MSS SP-58 Type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
- C. Corrosion Resistance: Use corrosion-resistant metal-based materials fully compatible with exposed piping materials and suitable for the environment where installed.
1. Galvanized Steel: Hot-dip galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M unless stated otherwise.
 2. Zinc-Plated Steel: Electroplated in accordance with ASTM B633 unless stated otherwise.
- D. Materials for Metal Fabricated Supports: Comply with Section 055000.
- E. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
- F. Provide hardware products listed, classified, and labeled as suitable for intended purpose.

- G. Provide required hardware to hang or support piping, equipment, or fixtures with related accessories as necessary to complete installation of plumbing work.

2.2 GENERAL REQUIREMENTS

- A. Pipe Supports, Thermal Insulated:
- B. Pipe Shields for Insulated Piping:

2.3 PIPE SUPPORTS, GUIDES, SHIELDS, AND SADDLES

- A. Stanchions:

2.4 PIPE ROLLERS AND ROLLER SUPPORTS

2.5 PIPE CLAMPS

- A. Riser Clamps:
- B. Clevis Hangers, Adjustable:

2.6 PIPE HANGERS

- A. Band Hangers, Adjustable:

2.7 STRUT SYSTEMS FOR PIPE OR EQUIPMENT SUPPORT

- A. Strut Channels:

2.8 PREFABRICATED TRAPEZE-FRAMED SYSTEMS

- A. Prefabricated Trapeze-Framed Metal Strut Systems:
- B. MSS SP-58 type 43 based on required load, nonconductive and corrosion resistant.
- C. Steel Yoke Type: MSS SP-58 type 44, vertically adjustable, nonconductive, and corrosion resistant.
- D. Material: Zinc plated ASTM A36/A36M carbon steel or ASTM A47/A47M malleable iron.
- E. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
 - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
 - 3. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
 - 4. MSS SP-58 type 40, ASTM A1011/A1011M steel or ASTM A653/A653M carbon steel.
 - 5. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.

- c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
- d. Service Temperature: Minus 40 to 178 degrees F.
- e. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

F. Pipe Supports:

- 1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
- 2. Liquid Temperatures Up to 122 degrees F:
 - a. Overhead Support: MSS SP-58 types 1, 3 through 12 clamps.
 - b. Support From Below: MSS SP-58 types 35 through 38.
- 3. General Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Provide pipe supports for 1/2 to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid phenolic foam insulation surrounded by 360 degree, PVC jacketing.
- 4. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Minimum Thickness: 60 mil, 0.06 inch.

G. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

H. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.

I. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.

2.9 ANCHORS AND FASTENERS

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.
- J. Ductwork shall not be damaged or penetrated by any supports.

END OF SECTION 220529

SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Pipe markers.
- E. Ceiling tacks.

1.2 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Identification painting.

1.3 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 PRODUCTS

2.1 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

- A. Tags:
 - 1. Piping: 3/4 inch diameter and smaller.
 - 2. Ceiling tacks placed on lay-in ceiling surface to reference plumbing components.
- B. Stencil:
 - 1. Piping: 3/4 inch diameter and higher.
 - 2. Ceiling tacks placed on lay-in ceiling surface to reference plumbing components.
- C. Pipe Markers: 3/4 inch diameter and higher.

2.2 NAMEPLATES

- A. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

2.3 TAGS

- A. Flexible: Vinyl with engraved black letters on light contrasting background color with up to three lines of text. Minimum tag size 1-1/2 inch in diameter.
- B. Metal: Brass, 19 gauge 1-1/2 inch in diameter with smooth edges, blank, smooth edges, and corrosion-resistant ball chain. Up to three lines of text.

2.4 STENCILS

- A. Stencil Paint: As specified in Section 099123, semi-gloss enamel, colors complying with ASME A13.1.
- B. Fluid Service Identification Scheme, ASME A13.1:
 - 1. Water; Potable, Cooling, Boiler Feed and Other: White text on green background.

2.5 PIPE MARKERS

- A. Comply with ASME A13.1.
- B. Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.
- C. Identification Scheme, ASME A13.1:
 - 1. Primary: External Pipe Diameter, Uninsulated or Insulated.
 - a. 3/4 to 1-1/4 inches: Use 8 inch field-length with 1/2 inch text height.
 - b. 1-1/2 to 2 inches: Use 8 inch field-length with 3/4 inch text height.
 - c. 2-1/2 to 6 inches: Use 12 inch field-length with 1-1/4 inch text height.
 - d. 8 to 10 inches: Use 24 inch field-length with 2-1/2 inch text height.
 - e. Over 10 inches: Use 32 inch field-length with 3-1/2 inch text height.
 - 2. Secondary: Color scheme per fluid service.
 - a. Compressed Air: White text on blue background.
 - b. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.

2.6 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags in clear view and align with axis of piping
- C. Install plastic pipe markers in accordance with manufacturer's instructions.

D. Apply ASME A13.1 Pipe Marking Rules:

1. Place pipe marker adjacent to changes in direction.
2. Place pipe marker adjacent each valve port and flange end.
3. Place pipe marker at both sides of floor and wall penetrations.
4. Place pipe marker every 25 to 50 feet interval of straight run.

E. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 220553

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SECTION 221005

PLUMBING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sanitary waste piping, buried within 5 feet of building.
- B. Sanitary waste piping, above grade.
- C. Domestic water piping, above grade.
- D. Pipe flanges, unions, and couplings.
- E. Pipe hangers and supports.
- F. Ball valves.

1.2 RELATED REQUIREMENTS

- A. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.
- B. Section 220529 - Hangers and Supports for Plumbing Piping and Equipment.
- C. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- D. Section 220553 - Identification for Plumbing Piping and Equipment.

1.3 REFERENCE STANDARDS

- A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- C. ASME B31.9 - Building Services Piping.
- D. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- F. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- G. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- H. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- I. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- J. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

- K. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- L. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- M. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- N. AWWA C606 - Grooved and Shouldered Joints.
- O. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
- P. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- R. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- S. NSF 61 - Drinking Water System Components - Health Effects.
- T. NSF 372 - Drinking Water System Components - Lead Content.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.2 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.3 SANITARY WASTE PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.4 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: Grooved mechanical couplings.
 - 3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

2.5 PIPE FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 inch and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
 - 2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.
- B. Flanges for Pipe Sizes Over 1 inch:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 - 2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Housing Material: Provide ASTM A47/A47M malleable iron, or ductile iron, galvanized.
 - 3. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.

4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

D. No-Hub Couplings:

1. Gasket Material: Neoprene complying with ASTM C564.
2. Band Material: Stainless steel.
3. Eyelet Material: Stainless steel.

- E. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.6 PIPE HANGERS AND SUPPORTS

- A. See Section 220529 for additional requirements.

- B. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
3. Trapeze Hangers: Welded steel channel frames attached to structure.
4. Vertical Pipe Support: Steel riser clamp.
5. Floor Supports: Concrete pier or steel pedestal with floor flange; fixture attachment.

- C. Plumbing Piping - Drain, Waste, and Vent:

1. Conform to ASTM B31.9.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
6. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

- D. Plumbing Piping - Water:

1. Conform to ASTM B31.9.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.
5. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
6. Wall Support for Pipe Sizes Up to 3 inch: Cast iron hook.
7. Wall Support for Pipe Sizes 4 inch and Larger: Welded steel bracket and wrought steel clamp.
8. Vertical Support: Steel riser clamp.

9. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.7 BALL VALVES

A. Manufacturers:

1. Apollo Valves.
2. Victaulic Company.
3. Watts.

- ### B. Construction, 4 inch and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

PART 3 EXECUTION

3.1 EXAMINATION

- #### A. Verify that excavations are to required grade, dry, and not over-excavated.

3.2 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. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- #### A. Install in accordance with manufacturer's instructions.
- #### B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- #### C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- #### D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- #### E. Provide all piping offsets and fittings as required for a quality installation.
- #### F. Group piping whenever practical at common elevations.
- #### G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 220516.
- #### H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- #### I. Provide access where valves and fittings are not exposed.

- J. Establish elevations of buried piping outside the building to ensure not less than 4 ft of cover.
- K. Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to roofing specification.
- L. Locate plumbing vent terminations a minimum of 10' away from air intakes.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- N. Provide support for utility meters in accordance with requirements of utility companies.
- O. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.
- P. Install valves with stems upright or horizontal, not inverted. See Section 220523.
- Q. Install water piping to ASME B31.9.
- R. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- S. Sleeve pipes passing through partitions, walls and floors constructed of a minimum of 18 gauge sheetmetal. Provide schedule 40 pipe as sleeves with appropriate sealant at fire and/or smoke rated penetrations around pipe sleeve. Extend sleeves through floors a minimum of 2" above the floor. Wall sleeves shall be flush with the wall and chrome plated solid steel escutcheons shall be installed.
- T. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- U. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping. Use Hydra-Zorb type clamps when copper piping is supported by uni-strut hangers.
 - 9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
 - 10. Provide hangers adjacent to motor-driven equipment with vibration isolation; see Section 220548.
 - 11. Support cast iron drainage piping at every joint.

- V. Install copper sanitary piping from sink and indirect fixture drains in commercial kitchen and cast iron piping in the kitchen and boiler rooms where high temperature water will be drained into the system.
- W. Provide chrome plated brass P-traps under lavatories and sinks. Provide chrome escutcheons at wall penetration of waste piping.
- X. Provide chrome plated water supply pipes, where exposed. Provide chrome escutcheons at wall penetration behind water supply stop valve.
- Y. Provide an isolation valve on each branch water pipe within 3' of the main.

3.4 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. All installations shall be done by factory-trained field personnel. Contractor shall remove and replace any improperly installed products.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers. Install isolation valves on all branch piping within 3 feet of mains.
- D. Provide spring-loaded check valves on discharge of water pumps.
- E. Provide flow controls in water recirculating systems where indicated.
- F. Provide extended valve stems on valves where piping is being insulated to provide required clearance from insulation to operate valve.

3.5 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.

3.6 FIELD TESTS AND INSPECTIONS

- A. Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.
- B. Testing of plumbing piping systems shall be witnessed by the Engineer. Provide a minimum of 24 hours of notice prior to the testing.
- C. Sanitary and Storm Systems:
 - 1. Hydrostatically test sanitary and storm drainage piping with 10 feet of water column for 1 hour.
- D. Domestic Water Systems:
 - 1. Perform hydrostatic testing for leakage prior to system disinfection.
 - 2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
 - 3. Hydrostatically test water piping with 125 psi of water pressure for 24 hours.

E. Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.7 SCHEDULES

A. Pipe Hanger Spacing:

1. Metal Piping:
 - a. Pipe Size: 1/2 inch to 1-1/4 inch:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inch to 2 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inch to 3 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - d. Pipe Size: 4 inch to 6 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.
 - e. Pipe Size: 8 inch to 12 inch:
 - 1) Maximum hanger spacing: 14 ft.
 - 2) Hanger Rod Diameter: 7/8 inch.
 - f. Pipe Size: 14 inch and Over:
 - 1) Maximum Hanger Spacing: 20 ft.
 - 2) Hanger Rod Diameter: 1 inch.
2. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum Hanger Spacing: 6 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.

END OF SECTION 221005

SECTION 221006

PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Drains.
- B. Cleanouts.
- C. Backflow preventers.
- D. Double check valve assemblies.
- E. Floor drain trap seals.

1.2 RELATED REQUIREMENTS

- A. Section 221005 - Plumbing Piping.
- B. Section 223000 - Plumbing Equipment.
- C. Section 224000 - Plumbing Fixtures.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks.
- B. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
- C. ASSE 1013 - Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.
- D. NSF 61 - Drinking Water System Components - Health Effects.
- E. NSF 372 - Drinking Water System Components - Lead Content.
- F. PDI-WH 201 - Water Hammer Arresters.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

- E. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.
- F. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept specialties on site in original factory packaging. Inspect for damage.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.2 DRAINS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company
 - 2. Josam Company
 - 3. MIFAB, Inc.
 - 4. Wade

2.3 CLEANOUTS

- A. Manufacturers:
 - 1. Jay R. Smith Manufacturing Company
 - 2. Wade
 - 3. Zurn Industries, LLC

2.4 BACKFLOW PREVENTERS

- A. Manufacturers:
 - 1. Apollo Valves
 - 2. Watts Regulator Company, a part of Watts Water Technologies
 - 3. Zurn Industries, LLC.
- B. Reduced Pressure Backflow Preventer Assembly:
 - 1. ASSE 1013; cast bronze body and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure, and non-threaded vent outlet.

2.5 DOUBLE CHECK-VALVE ASSEMBLIES

- A. Manufacturers:
 - 1. Apollo Valves
 - 2. Watts Regulator Company, a part of Watts Water Technologies

3. Zurn Industries, LLC.

B. Double Check Valve Assembly:

1. ASSE 1012; cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.

2.6 FLOOR DRAIN TRAP SEALS

A. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install all floor drains, floor sinks and roof drains with flashing clamps and flashings as recommended by manufacturer. Floor drains shall be provided with a Chloraloy flashing.
- F. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- G. Install approved potable water protection devices on plumbing lines where contamination of water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
- H. Pipe relief from backflow preventer to nearest drain.
- I. Install wall cleanouts to a minimum of 12" above highest flood rim of any associated fixture.

END OF SECTION 221006

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SECTION 230050

GENERAL MECHANICAL PROVISIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The work required under Heating, Ventilating, and Air Conditioning Contract shall include all material, labor, equipment and services necessary and reasonably incidental to the proper completion of the systems, and all special work as hereinafter specified and indicated on the drawings.
- B. All work shall be executed in such a manner as to interfere as little as possible with the normal functioning of the facility, including operations of all utility services and any equipment, and with work being done by others. Roads shall be kept clear of materials, etc., at all times so that there will be no interference with the usual traffic. Where necessary, on account of new work connecting to existing pipes, where utility services are required to be cut, they shall be cut and capped at suitable places where indicated by drawings, or in the absence of such indication, where directed by the Architect/Engineer. No road traffic or utility service such as water, gas, or steam shall be interrupted without prior approval of the Owner, and all arrangements for work which will involve such interference shall be made in advance with the Owner so that same can be effected in a minimum of time and interference.

1.2 RELATED SECTIONS

- A. See Front End Specifications for General Requirements.
- B. See Front End Specifications for General Conditions: Performance bond and labor and material payment bonds, warranty, and correction of work.
- C. See Front End Specifications for Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- D. See Front End Specifications for Execution and Closeout Requirements: Contract closeout procedures.
- E. Individual Product Sections: Specific requirements for operation and maintenance data.
- F. Individual Product Sections: Warranties required for specific products or Work.

1.3 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

- A. Drawings and specifications shall be taken together. Provide work specified and not indicated, or work indicated and not specified as though mentioned in both.
- B. In case of discrepancy between drawings and specifications, or within either document, the greater quantity of work and/or better quality shall be used for estimating and the matter brought to the Architect/Engineer's attention for a written decision.

- C. Drawings are to be interpreted as diagrammatic only, 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. It should be understood that the Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts so as to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining these locations. Contractor shall refer to the Architectural drawing for dimensions of walls, foundations, structural beams, and other structural building members. 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.
- D. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where such items are required by other sections of the specifications or where they are required for proper installation of the work, such items shall be furnished and installed.
- E. 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.
- F. Where words "provide", "install", or "furnished" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and connect up complete and ready for operation, the items mentioned.

1.4 COOPERATION AND PROGRESS

- A. Keep informed about the work of all other trades engaged in the project and execute the work in such a manner as not to delay or interfere with the progress of other contractors. This contractor shall schedule his work so that no other contractor is delayed in the execution of his work. Complete cooperation of all trades is expected. Employ a competent foreman on job throughout the entire project to ensure that coordination is maintained.
- B. Schedule and coordinate the work of this Division with the schedule of the contractor to progress the work expeditiously, and to avoid unnecessary delays.
- C. Examine fully the drawings and specifications for other contractors for other trades, and coordinate the installation of this work with the work of the other contractors. Consult and cooperate with other contractors for determining space requirements and for determining that adequate clearance is allowed with respect to his equipment, other equipment, and the building. The Owner's representative reserves the right to determine space priority in the event of interference between piping, conduit, ducts, and equipment of the various contractors.
- D. Conflicts between the drawings and the specification shall be called to the attention of the Owner's representative and Architect/Engineer. If clarification is not asked for prior to the taking of bids, it will be assumed that none is required and that the contractor is in agreement with the drawings and specifications as issued. If clarification is required after the Contract is awarded, such clarification will be made by the Architect/Engineer and his decision will be final.

- E. Coordinate the installation of all mechanical system components with all other trades, including structural components and electrical trades. Allocate space in the different areas to allow for the installation of ductwork, piping, sprinklers, waste and vents, and mechanical equipment above ceilings and in equipment spaces. Recommend rerouting, resizing or relocation of mechanical components, if necessary, so all trades can install their systems in the space allotted. Any proposed changes from the systems layout, on the drawings, shall be done in accordance with the design criteria specified in the applicable codes and shall be subject to the review and acceptance of the Architect/Engineer.
- F. After award of the Contract, and prior to start of construction, the General Contractor shall schedule a meeting with the contractor and all subcontractors responsible of the work items listed above. The purpose of the meeting is to introduce the coordination program and to determine its implementation in relation to the progress schedule.
- G. All contractors and subcontractors shall participate in the coordination process. Participation is mandatory. If a contractor or subcontractor fails to participate in the coordination process, the Owner reserves the right to do the following:
 - 1. Stop any and all construction progress payments for any work performed by the contractor. Such payments will be reinstated only after the contractor or subcontractor resumes participation in the coordination drawing process.
 - 2. Relocate and resize contractor's work components as necessary to ensure all components will be installed as intended. In the event the contractor did not participate in the coordination process, he will not be entitled to any contract cost increases or time extensions due to Owner initiated changes in the work.
- H. The contractor shall also be held responsible for any unnecessary rework by other trade contractors that is attributable to his failure to participate in the coordination process.
- I. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility because of the scale of the drawings. Each contractor is expected to have included in his bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process. The contractor will not be allowed any contract cost extra or time extension for changes dictated by the coordination process.
- J. Utility installation in congested areas is dependent on the sequence of utility installation as much as it is dependent on the physical size of the utilities. The contractors shall use the coordination process to properly sequence the installation of utilities as appropriate to ensure the above ceiling and congested area utility installation is satisfactory.

1.5 GUARANTEE

- A. The Contractor, by the acceptance of this specification and the signing of the Contract, acknowledges his acquaintance with all the requirements and guarantees that every part going to make up the system, will be the best of its respective kind and will be erected in a most thorough and substantial manner by none but experienced labor.
- B. The Contractor guarantees that all piping as provided in this specification will be free from all obstructions, and that all piping will be tight and drip free.
- C. The Contractor guarantees that, in the entire hydronic piping system, a continuous and noiseless circulation of water will be established to all fixtures; and that water may be drawn from any fixture without hammering.

- D. The Contractor guarantees that the entire system of ductwork will provide free circulation of air without objectionable noise and that all air distribution within the conditioned space will be draftless and reasonably quiet.
- E. The Contractor guarantees that all equipment and appliances will successfully and acceptably perform the work for which they are installed and that each will operate smoothly and quietly up to its rated capacity.
- F. The Contractor further guarantees himself responsible for any defects which may develop in any part of the system, including equipment, piping, fixtures and appliances, due to faulty workmanship, design or material; and to replace and make good, without cost to the Owner, any such faulty parts or construction which develop defects at any time within one (1) year from the date of substantial completion. The date of substantial completion shall be as defined in the Contract Documents. Any repairs or replacement required on account of defects, as outlined in this paragraph shall be made promptly upon written notice from the Architect.
- G. Natural wear, accident, or carelessness on the part of others, however, shall not be made good by the Contractor.

1.6 PROTECTION OF INSTALLED WORK AND MATERIAL STORED ON SITE

- A. The Contractor is responsible for all work installed by him until his contract is complete and shall protect it from injury by others.
- B. All piping, fittings, equipment and material to be stored on the jobsite for any period of time shall be protected from the weather in a manner that is acceptable to the Architect.

1.7 SITE VISIT

- A. Bidders are advised to visit the site and inform themselves as to all conditions, and failure to do so will in no way relieve the successful bidder from the necessity of furnishing any material or performing any work that may be required to complete the work in accordance with the true intent and meaning of the drawings and specifications without additional cost to the Owner.
- B. Before bidding the job, investigate, determine and verify locations and invert elevations of sanitary and storm sewers, city water mains and any other buried or overhead utilities on or near site. Determine such locations in conjunction with all public and private utility companies and with all authorities having jurisdiction.
- C. On projects where remodeling of an existing structure is in the scope of the project, the contractor shall field verify locations of existing piping and ductwork. The contractor shall verify the exact locations of existing piping and ductwork to which the new ductwork and new piping are to connect and if the locations of the existing piping and ductwork are different than that shown on the drawings, the contractor shall include the additional cost in his bid proposal. The contractor shall also field verify the locations of existing piping and ductwork that are in conflict with the routing of the new work, and include in his bid proposal monies for the rerouting of the existing work in order to accommodate the new work.

1.8 RULES, REGULATIONS AND CODES

- A. The Contractor shall become acquainted with the local codes, and in case of a discrepancy between plans or specifications and the local codes, the Contractor shall use the code requirements. The greater quantity of work and material and/or better quality shall be used for estimating and the matter brought to the Architect's attention for a written decision.

- B. Perform all work in strict accordance with all rules, regulations, codes, ordinances, or laws of Local, State, and Federal governments, or of other authorities having lawful jurisdiction. Comply therewith. Such rules, regulations, codes, ordinances, or laws include, but are not necessarily limited to, the following:
 - 1. State building and fire codes.
 - 2. State plumbing and mechanical codes.
 - 3. City building and fire codes.
 - 4. City plumbing and mechanical codes.
 - 5. American Gas Association.
 - 6. National Electric Code.
 - 7. National Fire Protection Association.
 - 8. Occupation Safety and Health Act.
- C. If the Contractor notes, at the time of bidding, any parts of the plans and specifications which are not in accord 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 his proposal a separate price required to make the system shown on the drawings comply with the codes and regulations.
- D. 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.

1.9 SUBSTITUTIONS

- A. The Architect/Engineer shall be the sole and final judge as to the suitability of items substituted for those specified.
- B. The entire cost of all changes of any type due to substitutions for materials specified shall be borne by the Contractor at no extra cost to the Owner.
- C. Unsolicited and voluntary deducts, on the part of the Contractor for substituting unapproved equipment, shall not be considered for the purpose of awarding the Contract.
- D. When the drawings and/or specifications refer to any item, article, material, method, fabrication, assembly or construction by means of one or more manufacturer's trade name, catalog reference or similar means of identification of manufacturer, the Contractor shall furnish one of the makes so identified without substitution unless other make or makes have been approved by addendum to the contract documents prior to the receipt of bids. Requests for the approval of items of equal quality are requested to be made in writing to the Architect/Engineer five days prior to the date of the receipt of bids so that a list of acceptable equal quality items can be made known to all bidders by an addendum. If substitution for names items, articles, materials, methods, fabrications, assembly or construction are approved, the Contractor assumes all responsibility for coordination and performing the related changes in the work necessitated by such substitutions and shall include in his bid all costs involved therein.

1.10 SHOP DRAWING REVIEW

- A. Shop drawings will be reviewed only to extent of information indicated. This check is only for review of general conformance with the design concept of the project and general compliance with the information given the contract documents. The contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication processes techniques of construction, coordinating his work in a safe and satisfactory manner.

- B. Review of shop drawings shall not relieve Contractor of responsibility for providing all controls, wiring, components, etc., which are shown or specified, or all additional controls, wiring, components, etc., required to provide complete and correctly operating mechanical systems.
- C. In cases where substituted equipment has been installed in place of specified equipment the Contractor shall bear the entire cost of all changes of any type due to the substitution, even though the shop drawings have been reviewed by the Architect/Engineer.
- D. Shop drawings in no way relieve the contractor from performing on the job as to the intent of the construction documents.

1.11 CONNECTING NEW WORK TO EXISTING WORK

- A. Connect new work to existing work in a neat workmanlike manner. In every case where any part of the existing work must be cut to install new work, or is damaged, same must be patched and repaired in a manner satisfactory to the Architect. Where relocation of existing equipment and piping systems is necessary in areas providing uninterruptible services, schedule work during slack periods. Anticipate scheduling work at a period which will result in additional construction cost, such as overtime for work to be done at night or on weekends. Include cost in the bid proposal.
- B. Do not cut into existing services without first informing the Owners representative as to the time and duration of shutdown of the existing services.
- C. Perform work that interrupts any service at a time that will cause least interference to the operation of the building.
- D. Maintain all existing services and equipment unless indicated to be removed.

1.12 ACCESS TO EQUIPMENT FOR MAINTENANCE

- A. Install all equipment, piping, etc., to permit access for normal maintenance. Maintain easy access to filters, motors, drive compressors, coils, etc. Install all such equipment and accessories to facilitate maintenance. Perform any relocation of pipes, ducts, etc. required to permit access at request of Architect/Engineer at no additional cost to Owner.

1.13 FIRE AND SMOKE STOPPAGE

- A. It shall be the responsibility of this Contractor to maintained and fire and smoke integrity of all walls, ceilings, floors, etc., through which this work passes through or into. Fire and smoke barriers shall be provided in and around as required by Codes.
- B. Where holes are required to be patched, or conduit, piping, ducts, etc., are required to be patched around, it shall be filled with a material that is UL Classified Standard 1479 for this use and Factory Mutual System approved.
- C. Fire and smoke stoppage material shall be water based with intumescent properties. Material may be in the form of caulking, putty pads or wrap strips. Materials shall be installed in accordance to manufacturers and UL standards.

1.14 TEMPORARY HEAT/COOLING

- A. Where temporary heating/cooling is needed after the building is enclosed, this may be provided through the use of the project's permanent heating/cooling equipment, but only after permission is obtained from the Owner/Architect.

- B. The cost of fuel/energy for the temporary heating/cooling shall be included in the project. The Mechanical Contractor shall coordinate these costs with the General Contractor as required.
- C. The Mechanical Contractor assumes responsibility for the operation and maintenance of the equipment during the temporary heating/cooling period. This operation shall not alter or void the specified warranty period from the time of acceptance of the entire project by the Owner.
- D. Temporary filters shall be placed in all equipment and in all return air openings and they shall be kept clean during operation. New filters shall be installed, unused, at the time of project completion.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION- NOT USED

END OF SECTION 230050

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SECTION 230501

CLOSEOUT SUBMITTALS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Project Record Documents.
- B. Operation and Maintenance Data.

1.2 RELATED SECTIONS

- A. See Front End Specifications for General Conditions: Performance bond and labor and material payment bonds, warranty, and correction of work.
- B. See Front End Specifications for Section 013300 – Submittal Procedures: Submittals procedures, shop drawings, product data, and samples.
- C. Individual Product Sections: Specific requirements for operation and maintenance data.
- D. Individual Product Sections: Warranties required for specific products or Work.

1.3 SUBMITTALS

- A. Project Record Documents: Submit documents to Engineer .
- B. Operation and Maintenance Data:
 - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
 - 3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Engineer comments. Revise content of all document sets as required prior to final submission.
 - 4. Submit two sets of revised final documents in final form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Addenda.
 - 3. Change Orders and other modifications to the Contract.
 - 4. Reviewed shop drawings, product data, and samples.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 2. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 3. Field changes of dimension and detail.

3.2 OPERATION AND MAINTENANCE DATA

- A. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.3 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.

- B. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- C. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- D. Provide servicing and lubrication schedule, and list of lubricants required.
- E. Include manufacturer's printed operation and maintenance instructions.
- F. Include sequence of operation by controls manufacturer.
- G. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- H. Provide control diagrams by controls manufacturer as installed.
- I. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.
- J. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- K. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- L. Include test and balancing reports.
- M. Additional Requirements: As specified in individual product specification sections.

3.4 OPERATION AND MAINTENANCE MANUALS

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.
- B. Prepare data in the form of an instructional manual.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Electronic files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required. Use files prepared by manufacturer when available. Enable bookmarking of individual documents based on file names. Submit on labeled USB flash drive or CD disc.
- E. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- F. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.

- G. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- H. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.
- I. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Air and water balance reports.
 - c. Photocopies of warranties and bonds.

END OF SECTION 230501

SECTION 230502

DEMONSTRATION AND TRAINING FOR HVAC SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Demonstration of products and systems where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. All software-operated systems.
 - 2. HVAC systems and equipment.

1.2 RELATED SECTIONS

- A. Section 230501 - Closeout Submittals: Operation and maintenance manuals.
- B. Other Specification Sections: Additional requirements for demonstration and training.

1.3 SUBMITTALS

- A. See Front End Specifications for submittal procedures.
- B. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
 - 1. Include applicable portion of O&M manuals.
 - 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
 - 3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- C. Video Recordings: Submit digital video recording of each demonstration and training session for Owner's subsequent use.
 - 1. Format: USB flash drive or DVD Disc.
 - 2. Label each disc and container with session identification and date.
- D. System Diagrams: Require system diagrams to be mounted in each mechanical equipment room with stainless steel frame and clear acrylic front, with all operating piping, valves, controls, and air and water flows shown. Final balance flows, pressures, temperatures, motor horsepower, pump and fan curves, and belt sizes shall be shown.

1.4 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
 - 1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.

2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 DEMONSTRATION - GENERAL

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstration may be combined with Owner personnel training if applicable.
- C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
 1. Perform demonstrations not less than two weeks prior to Substantial Completion.
 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.2 TRAINING - GENERAL

- A. Conduct training on-site unless otherwise indicated.
- B. Provide training in minimum two hour segments.
- C. Contractor shall make owner aware of all items that require annual and semi-annual inspection, including all applicable fees.
- D. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
 1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 3. Typical uses of the O&M manuals.
- E. Product- and System-Specific Training:
 1. Review the applicable O&M manuals.
 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.

4. Provide hands-on training on all operational modes possible and preventive maintenance.
 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 6. Discuss common troubleshooting problems and solutions.
 7. Discuss any peculiarities of equipment installation or operation.
 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 10. Review spare parts and tools required to be furnished by Contractor.
 11. Review spare parts suppliers and sources and procurement procedures.
- F. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION 230502

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SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General construction and requirements.
- B. Applications.
- C. Single-phase electric motors.
- D. Three-phase electric motors.
- E. Electronically Commutated Motors (ECM).

1.2 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
- C. NEMA MG 1 - Motors and Generators.
- D. NFPA 70 - National Electrical Code.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 104 degrees F environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 4. Comply with IEEE 841 for severe-duty motors.
- B. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

C. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.2 APPLICATIONS

- A. Motors located in exterior locations and air cooled condensers: Totally enclosed type.

2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- B. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- B. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- C. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Design, Construction, Testing, and Performance: Comply with NEMA MG 1 for Design B motors.
- B. Insulation System: NEMA Class B or better.
- C. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- D. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- E. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

- F. Sound Power Levels: To NEMA MG 1.
- G. Nominal Efficiency: As indicated at full load and rated voltage when tested in accordance with IEEE 112.
- H. Provide shaft grounding rings.
- I. Motors used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- J. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

2.7 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Operating Mode: Constant CFM, speed, or torque per application.
- B. Input: Motor manufacturer to coordinate control requirements with the control board of the equipment and/or specified sequence of operation.
- C. Shaft extension: Single
- D. Options: Remote mount control or user interface where called for on plans.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION 230513

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SECTION 230519

METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.
- C. Static pressure gauges.
- D. Filter gauges.

1.2 RELATED REQUIREMENTS

- A. Section 230923 - Direct-Digital Control System for HVAC.
- B. Section 232113 - Hydronic Piping.

1.3 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.

1.4 SUBMITTALS

- A. See Front End Specifications for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.1 PRESSURE GAUGES

- A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.

2.2 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.

- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
- D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

- A. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
 - 1. Size: 9 inch scale.
 - 2. Accuracy: 2 percent, per ASTM E77.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Accuracy: 2 percent, per ASTM E77.
 - 3. Calibration: Degrees F.

2.4 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.5 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
- B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauges, one gauge adapters with 1/8 inch probes, two 1 inch dial thermometers.

2.6 STATIC PRESSURE GAUGES

- A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- B. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- D. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- E. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- F. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- G. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION 230519

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SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components.

1.2 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping.
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- F. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- G. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- H. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- K. FM (AG) - FM Approval Guide.
- L. MFMA-4 - Metal Framing Standards Publication.
- M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- N. UL (DIR) - Online Certifications Directory.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
2. Coordinate the work with other trades to provide additional framing and materials required for installation.
3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Engineer/Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.4 SUBMITTALS

A. See Front End Specifications for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

C. Shop Drawings: Include details for fabricated hangers and supports.

1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 QUALITY ASSURANCE

A. Comply with applicable building code.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of Mechanical and/or Plumbing work.

2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Prefabricated Trapeze-Framed Metal Strut Systems:
1. MFMA-4 compliant, pre-fabricated, MSS SP-58 type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
 2. Strut Channel or Bracket Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 3. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
 4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
 5. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.
- C. Hanger Rods:
1. Threaded zinc-plated steel unless otherwise indicated.
- D. Thermal Insulated Pipe Supports:
1. General Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
 2. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 60 mil.

- E. Pipe Supports:
1. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
 2. Liquid Temperatures Up To 122 degrees F:
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
- F. Roller Chairs:
1. MSS SP-58 type 43 based on required load, nonconductive and corrosion resistant.
 2. Steel Yoke Type: MSS SP-58 type 44, vertically adjustable, nonconductive, and corrosion resistant.
 3. Material: Zinc plated ASTM A36/A36M carbon steel or ASTM A47/A47M malleable iron.
- G. Pipe Stanchions:
1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
 3. For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
- H. Riser Clamps:
1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
 2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.
 3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
 4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
 5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.
- I. Pipe Hangers:
1. Split Ring Hangers:
 - a. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.
 - b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
 - c. Provide hanger rod and nuts of the same type and material for a given pipe run.
 - d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
 2. Clevis Hangers, Adjustable:
 - a. Light-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
 - b. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
 - c. UL (DIR) listed: Pipe sizes 2-1/2 to 8 inch.
 - d. FM (AG) listed: Pipe sizes 2-1/2 to 8 inch.
- J. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

- K. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
 3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- L. Pipe Shields for Insulated Piping:
1. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- M. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Engineer and/or Structural Engineer, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:
1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.

3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION 230529

SECTION 230548

VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vibration isolation requirements.
- B. Vibration isolators.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 230529 - Hangers and Supports for HVAC Piping and Equipment.

1.3 DEFINITIONS

- A. HVAC Component: Where referenced in this section in regards to seismic controls, applies to any portion of the HVAC system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., ductwork, piping).

1.4 REFERENCE STANDARDS

- A. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.6 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.

- B. Design Documents: Prepare and submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, details, and calculations.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.
 - 1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification methods for spring element load capacities.
- D. Shop Drawings - Vibration Isolation Systems:
 - 1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators; indicate equipment weights and static deflections.

1.7 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION REQUIREMENTS

- A. Design and provide vibration isolation systems to reduce vibration transmission to supporting structure from vibration-producing HVAC equipment and/or HVAC connections to vibration-isolated equipment.
- B. Comply with applicable general recommendations of ASHRAE (HVACA), where not in conflict with other specified requirements:
- C. General Requirements:
 - 1. Select vibration isolators to provide required static deflection.
 - 2. Select vibration isolators for uniform deflection based on distributed operating weight of actual installed equipment.
- D. Equipment Isolation: As indicated on drawings.
- E. Piping Isolation:
 - 1. Provide vibration isolators for piping supports:
 - a. Located in equipment rooms.
 - b. Located within 50 feet of connected vibration-isolated equipment and pressure-regulating valve (PRV) stations.
 - c. For piping over 2 inch located below or within 50 feet of noise-sensitive areas indicated.
 - 2. Minimum Static Deflection:
 - a. First Three Supports Closest to Isolated Equipment: Same as static deflection of equipment; maximum of 2 inch deflection required.
 - 3. Suspended Piping, Nonseismic Applications: Use resilient material isolator hangers, spring isolator hangers, or combination resilient material/spring isolator hangers.

4. Floor-Mounted Piping, Nonseismic Applications: Use open (unhoused) spring isolators.
5. Use modular seal or approved resilient material where vibration-isolated piping penetrates building elements (e.g., walls, floors) arranged to prevent vibration transmission to structure.

2.2 VIBRATION ISOLATORS

A. Manufacturers:

1. Vibration Isolators:
 - a. Kinetics Noise Control, Inc.
 - b. Mason Industries.
 - c. Vibration Eliminator Company, Inc.
2. Source Limitations: Furnish vibration-isolators and associated accessories produced by a single manufacturer and obtained from a single supplier.

B. General Requirements:

1. Resilient Materials for Vibration Isolators: Oil, ozone, and oxidant resistant.
2. Spring Elements for Spring Isolators:
 - a. Color code or otherwise identify springs to indicate load capacity.
 - b. Lateral Stability: Minimum lateral stiffness to vertical stiffness ratio of 0.8.
 - c. Designed to operate in the linear portion of their load versus deflection curve over deflection range of not less than 50 percent above specified deflection.
 - d. Designed to provide additional travel to solid of not less than 50 percent of rated deflection at rated load.
 - e. Selected to provide designed deflection of not less than 75 percent of specified deflection.
 - f. Selected to function without undue stress or overloading.

C. Vibration Isolators for Nonseismic Applications:

1. Resilient Material Isolator Pads:
 - a. Description: Single or multiple layer pads utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material.
 - b. Pad Thickness: As required for specified minimum static deflection; minimum 0.25 inch thickness.
 - c. Multiple Layer Pads: Provide bonded, galvanized sheet metal separation plate between each layer.
2. Resilient Material Isolator Mounts, Nonseismic:
 - a. Description: Mounting assemblies for bolting equipment to supporting structure utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material; fail-safe type.
3. Open (Unhoused) Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) without a housing.
 - b. Bottom Load Plate: Nonskid, molded, elastomeric isolator material or steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.

4. Housed Spring Isolators:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing.
 - b. Furnished with integral elastomeric snubbing elements, nonadjustable type, for limiting equipment movement and preventing metal-to-metal contact between housing elements.
 - c. Bottom Load Plate: Steel with nonskid, elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - d. Furnished with integral leveling device for positioning and securing supported equipment.
5. Restrained Spring Isolators, Nonseismic:
 - a. Description: Isolator assembly consisting of single or multiple free-standing, laterally stable steel spring(s) within a metal housing designed to prevent movement of supported equipment above an adjustable vertical limit stop.
 - b. Bottom Load Plate: Steel with nonskid elastomeric isolator pad with provisions for bolting to supporting structure as required.
 - c. Furnished with integral leveling device for positioning and securing supported equipment.
 - d. Provides constant free and operating height.
6. Resilient Material Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the lower hanger rod connection.
7. Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) in series with an elastomeric element for the lower hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
8. Combination Resilient Material/Spring Isolator Hangers, Nonseismic:
 - a. Description: Isolator assembly designed for installation in hanger rod suspension system utilizing single or multiple free-standing, laterally stable steel spring(s) for the lower hanger rod connection and elastomeric (e.g., neoprene, rubber) or fiberglass isolator material for the upper hanger rod connection.
 - b. Designed to accommodate misalignment of bottom hanger rod up to 30 degrees (plus/minus 15 degrees) without short-circuiting of isolation.
9. Thrust Restraints:
 - a. Description: Assembly utilizing free-standing, laterally stable steel spring designed for resisting horizontal motion due to thrust (e.g., air pressure from a fan), and intended for installation in pairs.

2.3 ACOUSTICAL AND VIBRATION ISOLATORS

A. General Requirements:

1. Acoustical Isolation System: Through-stud isolators, pipe clamps, riser clamp pads, neoprene and felt lining material and associated support brackets.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Secure fasteners according to manufacturer's recommended torque settings.
- D. Install flexible piping connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.
- E. Vibration Isolation Systems:
 - 1. Spring Isolators:
 - a. Position equipment at operating height; provide temporary blocking as required.
 - b. Lift equipment free of isolators prior to lateral repositioning to avoid damage to isolators.
 - c. Level equipment by adjusting isolators gradually in sequence to raise equipment uniformly such that excessive weight or stress is not placed on any single isolator.
 - 2. Isolator Hangers:
 - a. Use precompressed isolator hangers where required to facilitate installation and prevent damage to equipment utility connection provisions.
 - b. Locate isolator hangers at top of hanger rods in accordance with manufacturer's instructions.
 - 3. Thrust Restraints:
 - a. Adjust restraint movement under normal operating static pressure.
 - 4. Clean debris from beneath vibration-isolated equipment that could cause short-circuiting of isolation.
 - 5. Use elastomeric grommets for attachments where required to prevent short-circuiting of isolation.
 - 6. Adjust isolators to be free of isolation short circuits during normal operation.
 - 7. Do not overtighten fasteners such that resilient material isolator pads are compressed beyond manufacturer's maximum recommended deflection.

END OF SECTION 230548

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SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.2 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Automatic Controls: Tags. Key to control schematic.
- C. Control Panels: Nameplates.
- D. Dampers: Ceiling tacks, where located above lay-in ceiling.
- E. Heat Transfer Equipment: Nameplates.
- F. Instrumentation: Tags.
- G. Major Control Components: Nameplates.
- H. Piping: Tags.
- I. Pumps: Nameplates.
- J. Small-sized Equipment: Tags.
- K. Tanks: Nameplates.
- L. Thermostats: Nameplates.

M. Valves: Tags and ceiling tacks where located above lay-in ceiling.

N. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

A. Letter Color: White.

B. Letter Height: 1/4 inch.

C. Background Color: Black.

2.3 TAGS

A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.

B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.

2.4 ADHESIVE-BACKED DUCT MARKERS

A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

B. Style: Individual Label.

C. Color: Yellow/Black.

2.5 STENCILS

A. Stencil Paint: As specified in Section 099123, semi-gloss enamel, colors complying with ASME A13.1.

2.6 PIPE MARKERS

A. Color: Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

2.7 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.2 SCHEDULE

A. Piping

1.	Chilled Water Supply	Green	CWS
2.	Chilled Water Return	Green	CWR
3.	Heating Water Supply	Green	HWS
4.	Heating Water Return	Green	HWR
5.	Low Pressure Steam	Green	LPS
6.	Steam Condensate Return	Green	CR
7.	Condensate Drains	Green	CD

END OF SECTION 230553

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SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and steam systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Commissioning activities.

1.2 RELATED REQUIREMENTS

- A. Section 019113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- B. Section 230800 - Commissioning of HVAC.

1.3 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.

1.4 SUBMITTALS

- A. See Front End Specifications for submittal procedures.
- B. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Procedures for formal deficiency reports, including scope, frequency and distribution.

- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
- D. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. NEBB (TAB), Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.

3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide additional balancing devices as required.

3.4 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- M. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.8 COMMISSIONING

- A. See Sections 019113 - General Commissioning Requirements and 230800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 - 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.9 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Plumbing Pumps.
 - 2. HVAC Pumps.
 - 3. Air Cooled Water Chillers.
 - 4. Packaged Roof Top Heating/Cooling Units.
 - 5. Fans.
 - 6. Air Filters.
 - 7. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.
 - 4. Phase, voltage, amperage; nameplate, actual, no load.
 - 5. RPM.
 - 6. Service factor.
 - 7. Starter size, rating, heater elements.
 - 8. Sheave Make/Size/Bore.
- B. V-Belt Drives:
 - 1. Identification/location.
 - 2. Required driven RPM.
 - 3. Driven sheave, diameter and RPM.
 - 4. Belt, size and quantity.
 - 5. Motor sheave diameter and RPM.
 - 6. Center to center distance, maximum, minimum, and actual.
- C. Pumps:
 - 1. Identification/number.
 - 2. Manufacturer.
 - 3. Size/model.
 - 4. Impeller.
 - 5. Service.
 - 6. Design flow rate, pressure drop, BHP.
 - 7. Actual flow rate, pressure drop, BHP.
 - 8. Discharge pressure.
 - 9. Suction pressure.
 - 10. Total operating head pressure.
 - 11. Shut off, discharge and suction pressures.
 - 12. Shut off, total head pressure.

D. Chillers:

1. Identification/number.
2. Manufacturer.
3. Capacity.
4. Model number.
5. Serial number.
6. Evaporator entering water temperature, design and actual.
7. Evaporator leaving water temperature, design and actual.
8. Evaporator pressure drop, design and actual.
9. Evaporator water flow rate, design and actual.

E. Heat Exchangers:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Model number.
6. Serial number.
7. Steam pressure, design and actual.
8. Primary water entering temperature, design and actual.
9. Primary water leaving temperature, design and actual.
10. Primary water flow, design and actual.
11. Primary water pressure drop, design and actual.
12. Secondary water leaving temperature, design and actual.
13. Secondary water flow, design and actual.
14. Secondary water pressure drop, design and actual.

F. Cooling Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Entering air DB temperature, design and actual.
7. Entering air WB temperature, design and actual.
8. Leaving air DB temperature, design and actual.
9. Leaving air WB temperature, design and actual.
10. Water flow, design and actual.
11. Water pressure drop, design and actual.
12. Entering water temperature, design and actual.
13. Leaving water temperature, design and actual.
14. Saturated suction temperature, design and actual.
15. Air pressure drop, design and actual.

G. Heating Coils:

1. Identification/number.
2. Location.
3. Service.
4. Manufacturer.
5. Air flow, design and actual.
6. Water flow, design and actual.
7. Water pressure drop, design and actual.
8. Entering water temperature, design and actual.
9. Leaving water temperature, design and actual.
10. Entering air temperature, design and actual.
11. Leaving air temperature, design and actual.
12. Air pressure drop, design and actual.

H. Air Moving Equipment:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Arrangement/Class/Discharge.
6. Air flow, specified and actual.
7. Return air flow, specified and actual.
8. Outside air flow, specified and actual.
9. Total static pressure (total external), specified and actual.
10. Inlet pressure.
11. Discharge pressure.
12. Sheave Make/Size/Bore.
13. Number of Belts/Make/Size.
14. Fan RPM.

I. Return Air/Outside Air:

1. Identification/location.
2. Design air flow.
3. Actual air flow.
4. Design return air flow.
5. Actual return air flow.
6. Design outside air flow.
7. Actual outside air flow.
8. Return air temperature.
9. Outside air temperature.
10. Required mixed air temperature.
11. Actual mixed air temperature.
12. Design outside/return air ratio.
13. Actual outside/return air ratio.

J. Exhaust Fans:

1. Location.
2. Manufacturer.
3. Model number.
4. Serial number.
5. Air flow, specified and actual.
6. Total static pressure (total external), specified and actual.
7. Inlet pressure.
8. Discharge pressure.
9. Sheave Make/Size/Bore.
10. Number of Belts/Make/Size.
11. Fan RPM.

K. Duct Traverses:

1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test air flow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

L. Duct Leak Tests:

1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

M. Air Distribution Tests:

1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.

6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

N. Sound Level Reports:

1. Location.
2. Octave bands - equipment off.
3. Octave bands - equipment on.

END OF SECTION 230593

SECTION 230713

DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Jacketing and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 230553 - Identification for HVAC Piping and Equipment.
- B. Section 233100 - HVAC Ducts and Casings: Glass fiber ducts.

1.3 REFERENCE STANDARDS

- A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- D. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- E. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- F. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation.
- G. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- H. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
- I. ASTM C1371 - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- K. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- L. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

M. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

N. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. See Front End Specifications for submittal procedures.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.

B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, FLEXIBLE

A. Manufacturer:

1. CertainTeed Corporation.
2. Johns Manville: www.jm.com/#sle.
3. Knauf Insulation; Atmosphere Duct Wrap.
4. Owens Corning Corporation.

B. Insulation: ASTM C553; flexible, noncombustible blanket.

1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
2. Maximum Service Temperature: 1,200 degrees F.
3. Maximum Water Vapor Absorption: 5.0 percent by weight.

C. Vapor Barrier Jacket:

1. Kraft paper with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
3. Secure with pressure-sensitive tape.

- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E. Indoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- F. Outdoor Vapor Barrier Mastic:
 - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- G. Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation.
 - 2. Johns Manville.
 - 3. Knauf Insulation.
 - 4. Owens Corning Corporation.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent.
 - 4. Maximum Density: 8.0 pcf.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Armacell LLC; ArmaFlex Ultra with FlameDefense.
 - 2. K-Flex USA LLC; Insul-Sheet.
 - 3. Substitutions: See Section 016000 - Product Requirements

- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.5 RIGID, POLYISOCYANURATE CELLULAR FOAM

- A. Manufacturers:
 - 1. Johns Manville
 - 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
 - 1. Dimension: Comply with requirements of ASTM C585
 - 2. K (Ksi) Value: 0.18 at 75 degrees F (0.026 at 24 degrees C), when tested in accordance with ASTM C518.
 - 3. Minimum Service Temperature: Minus 70 degrees F (Minus 57 degrees C).
 - 4. Maximum Service Temperature: 300 degrees F (150 degrees C).
 - 5. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842.
 - 6. Moisture Vapor Transmission: 4.0 perm inch (5.8 ng/(Pa s m))
 - 7. Connection: Waterproof vapor barrier adhesive.

2.6 RIGID, CELLULAR PHENOLIC

- A. Manufacturers:
 - 1. Johns Manville
 - 2. KoolDuct
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
 - 1. Dimension: Comply with requirements of ASTM C585
 - 2. K (Ksi) Value: 0.18 at 75 degrees F (0.026 at 24 degrees C), when tested in accordance with ASTM C518.
 - 3. Minimum Service Temperature: Minus 70 degrees F (Minus 57 degrees C).
 - 4. Maximum Service Temperature: 300 degrees F (150 degrees C).
 - 5. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842.
 - 6. Moisture Vapor Transmission: 4.0 perm inch (5.8 ng/(Pa s m))
 - 7. Connection: Waterproof vapor barrier adhesive.

2.7 JACKETING AND ACCESSORIES

- A. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lbs./square.
- B. Aluminum Jacket:
 - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 2. Thickness: 0.016 inch sheet.
 - 3. Finish: Smooth.
 - 4. Joining: Longitudinal slip joints and 2 inch laps.
 - 5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
 - 6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- C. Flexible Weather-Proofing Outdoor Jacket: Self-healing, field-applied outdoor cladding.
 - 1. Material: Aluminum foil/polymer laminate with rubberized asphalt layer and acrylic adhesive.
 - 2. Thickness: 34 mil, 0.034 inch.
 - 3. Finish: Embossed.
 - 4. Color: Silver.
 - 5. Water Vapor Transmission: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - 6. Mold Resistance: Pass when tested in accordance with ASTM C1338.
 - 7. Emissivity: 0.30 when tested in accordance with ASTM C1371.
 - 8. Manufacturers:
 - a. Polyguard Products; Alumaguard.

2.8 DUCT LINER

- A. Manufacturers:
 - 1. Armacell LLC; ArmaFlex Ultra with FlameDefense.
 - 2. CertainTeed Corporation.
 - 3. Johns Manville: www.jm.com/#sle.
 - 4. Owens Corning Corporation; QuietR Rotary Duct Insulation.
 - 5. Knauf Insulation.
- B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Fungal Resistance: No growth when tested according to ASTM G21.
 - 4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1/2 inch Thickness: 0.30.
 - b. 1 inch Thickness: 0.40.
 - 6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm when tested in accordance with ASTM C1071.
 - 7. Connection: Waterproof vapor barrier adhesive.

- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- D. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
 - 1. Fungal Resistance: No growth when tested according to ASTM G21.
 - 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 - 3. Service Temperature: Up to 250 degrees F.
 - 4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1/2 inch Thickness: 0.30.
 - b. 1 inch Thickness: 0.45.
- E. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- F. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with calked aluminum jacket with seams located on bottom side of horizontal duct section.
- E. External Duct Insulation Application:
 - 1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 - 2. Secure insulation without vapor barrier with staples, tape, or wires.
 - 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 - 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

F. Duct and Plenum Liner Application:

1. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
2. Seal and smooth joints. Seal and coat transverse joints.
3. Seal liner surface penetrations with adhesive.
4. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.2 SCHEDULES

A. Return, Relief, and Exhaust Ducts Within 25 ft of Connected Fan Inlet: 1 inch thick internal duct liner

B. Outside Air Ducts and Plenums in Concealed or Exposed Locations:

1. Minimum R-value: 12
2. Insulation Materials:
 - a. Rigid Fiberglass
 - b. Cellular Glass
 - c. Phenolic

C. Supply Air Ducts in Concealed Locations

1. Minimum R-value: 6
2. Insulation Materials: Flexible Glass Fiber Duct Wrap

D. Supply Air Ducts in Exposed Locations

1. Minimum R-Value: 6
2. Insulation Materials:
 - a. External Applications, such as Mechanical Rooms and the like:
 - 1) Rigid Fiberglass
 - 2) Cellular Glass
 - 3) Phenolic
 - 4) Provide white all-service jacket (vapor barrier) with self-serving lap, or taped joints.
 - b. Internally Lined:
 - 1) Rectangular Ducts: Flexible glass liner.
 - 2) Spiral Ducts: Flexible glass liner within a perforated double-wall spiral duct.

E. Relief, Return, and Exhaust Ducts, and Plenums, and Air Devices in Concealed Locations Under an Exposed Roof.

1. Minimum R-value: 6
2. Insulation Materials: Flexible Glass Fiber Duct Wrap

- F. Ducts Exposed to Outdoors or in an Uninsulated and Unconditioned Space within the Building Envelope:
1. Minimum R-Value: 12
 2. Insulation Materials:
 - a. Polyisocyanurate Cellular Foam
 - b. Rigid Cellular Phenolic
 - c. Make watertight with Flexible Weather-Proofing Outdoor Jacket and hard cast sealant on all external seams.
 3. External duct systems such as Thermaduct or Pro-R by Ducts and Cleats are acceptable. Submit alternate manufacturers for approval.

END OF SECTION 230713

SECTION 230716

HVAC EQUIPMENT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Equipment insulation.
- B. Jacketing and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 230553 - Identification for HVAC Piping and Equipment.
- B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.
- C. Section 232114 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

- A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- E. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- F. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
- G. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- H. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. See Front End Specifications for submittal procedures.

- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, RIGID

- A. Manufacturer:
1. CertainTeed Corporation.
 2. Johns Manville Corporation.
 3. Owens Corning Corporation.
 4. Knauf Insulation.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 1,200 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 4. Maximum Density: 8.0 pcf.
- C. Vapor Barrier Jacket:
1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with self-sealing longitudinal laps and butt strips.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 CELLULAR GLASS

- A. Manufacturer:
1. Owens Corning Corporation.
 2. Substitutions: See Front End Specifications for Administrative Requirements.
- B. Block Insulation: ASTM C552, Type I, Grade 6.
1. K Value: 0.35 at 100 degrees F.
 2. Service Temperature: 800 degrees F, maximum.
 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 4. Water Absorption: 0.5 percent by volume, maximum.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc.
 - 2. Armacell LLC.
 - 3. K-Flex USA LLC.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 RIGID, CELLULAR PHENOLIC

- A. Insulation: ASTM C1126, Type III, Grade 1.
 - 1. Nominal Density: 3.75 pcf.
 - 2. Preliminary Initial Minimum K Value: 0.145 at 50 degrees F based on density of 2.5 pcf.
 - 3. Maximum Service Temperature: 248 degrees F.
 - 4. Minimum Service Temperature: Minus 292 degrees F.
 - 5. Minimum compressive strength as determined by ASTM D1621.
 - 6. Minimum tensile strength as determined by ASTM D1623.

2.6 JACKETING AND ACCESSORIES

- A. PVC Plastic:
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - b. Substitutions: See Front End Specifications for Administrative Requirements.
 - 2. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch.
 - e. Connections: Tacks.
 - 3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket:
 - 1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 - 2. Thickness: 0.016 inch sheet.
 - 3. Finish: Smooth.
 - 4. Joining: Longitudinal slip joints and 2 inch laps.
 - 5. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands. Removable components shall use Velcro applied to both equipment and insulation with waterproof adhesive such that pieces can be removed for servicing and inspection and re-installed without damage.
- D. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- E. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- F. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- G. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- H. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation so it can be easily removed and replaced without damage.

3.2 SCHEDULE

- A. Heating Systems:
 - 1. Heat Exchangers/Converters: Rigid Cellular Glass, Phenolic, or Rigid Glass Fiber. 1" thick.
 - 2. Air Separators: Rigid Cellular Glass, Phenolic, or Rigid Glass Fiber. 1" thick.
 - 3. Expansion Tanks: Rigid Cellular Glass, Phenolic, or Rigid Glass Fiber. 1" thick.
 - 4. Steam Condensate Receivers: Rigid Cellular Glass, Phenolic, or Rigid Glass Fiber. 1" thick.
- B. Cooling Systems:
 - 1. Pump Bodies: Rigid Cellular Glass, Phenolic, or Flexible Elastomeric Cellular. 1" thick.
 - 2. Air Separators: Rigid Cellular Glass, Phenolic, or Flexible Elastomeric Cellular. 1" thick.
 - 3. Heat Exchanger: Rigid Cellular Glass, Phenolic, or Flexible Elastomeric Cellular. 1" thick.
 - 4. Expansion Tanks: Rigid Cellular Glass, Phenolic, or Flexible Elastomeric Cellular. 1" thick.
 - 5. Cold Thermal Storage Tanks: Rigid Cellular Glass, Phenolic, or Flexible Elastomeric Cellular. 1" thick.

END OF SECTION 230716

SECTION 230719
HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jacketing and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 232113 - Hydronic Piping: Placement of hangers and hanger inserts.

1.3 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- B. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- D. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- E. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
- H. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- J. ASTM C1126 - Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- K. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics.
- L. ASTM D1623 - Standard Test Method for Tensile And Tensile Adhesion Properties of Rigid Cellular Plastics.

- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- N. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. See Front End Specifications for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 GLASS FIBER, RIGID

- A. Manufacturers:
 - 1. CertainTeed Corporation
 - 2. Johns Manville Corporation
 - 3. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
 - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- G. Insulating Cement: ASTM C449.

2.3 CELLULAR GLASS

A. Manufacturers:

1. Owens Corning Corporation
2. Johns Manville Corporation
3. Substitutions: See Section 016000 - Product Requirements.

B. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.

1. K Value: 0.35 at 100 degrees F.
2. Service Temperature Range: From 250 degrees F to 800 degrees F.
3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
4. Water Absorption: 0.5 percent by volume, maximum.
5. Density: A minimum of 6.12 pcf.

C. Block Insulation: ASTM C552, Type I, Grade 6.

1. K Value: 0.35 at 100 degrees F.
2. Service Temperature: 800 degrees F, maximum.
3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
4. Water Absorption: 0.5 percent by volume, maximum.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturers:

1. Aeroflex USA, Inc; Aerocel Stay-Seal with Protape (SSPT)
2. Armacell LLC; ArmaFlex Ultra with FlameDefense
3. K-Flex USA LLC; K-Flex Titan

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.

1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 180 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.5 RIGID, CELLULAR PHENOLIC

A. Insulation: ASTM C1126, Type III, Grade 1.

1. Nominal Density: 3.75 pcf.
2. Preliminary Initial Minimum K Value: 0.145 at 50 degrees F based on density of 2.5 pcf.
3. Maximum Service Temperature: 248 degrees F.
4. Minimum Service Temperature: Minus 292 degrees F.
5. Minimum compressive strength as determined by ASTM D1621.
6. Minimum tensile strength as determined by ASTM D1623.

2.6 JACKETING AND ACCESSORIES

A. PVC Plastic.

1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch.
 - e. Connections: Brush on welding adhesive.
2. Covering Adhesive Mastic: Compatible with insulation.

B. Aluminum Jacket:

1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
2. Thickness: 0.016 inch sheet.
3. Finish: Smooth.
4. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

C. Stainless Steel Jacket: ASTM A666, Type 304 stainless steel.

1. Thickness: 0.010 inch.
2. Finish: Smooth.
3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

2.7 ACCESSORIES

A. General Requirements:

1. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.
2. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
3. Supply materials that are asbestos free.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

- D. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- G. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- H. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 078400.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.2 SCHEDULE

- A. Heating Systems:
 - 1. Heating Water Supply and Return:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to 1-1/2", 1-1/2 inch thickness.
 - 2) Pipe Size Range: 2" and over, 2 inch thickness.

2. Low Pressure Steam Piping:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to 1-1/2", 2-1/2 inch thickness.
 - 2) Pipe Size Range: 2" and over, 2-1/2 inch thickness.
 3. Low Pressure and Pump Steam Condensate:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to 1-1/2", 1-1/2 inch thickness.
 - 2) Pipe Size Range: 2" and over, 2 inch thickness.
- B. Cooling Systems:
1. Chilled Water:
 - a. Cellular Glass or Phenolic Insulation:
 - 1) Pipe Size Range: Up to 1-1/2", 1-1/2 inch thickness.
 - 2) Pipe Size Range: 2" and over, 2 inch thickness.
 - b. Glass Fiber Insulation:
 - 1) Pipe Size Range: Up to 1-1/2", 1-1/2 inch thickness.
 - 2) Pipe Size Range: 2" and over, 2 inch thickness.
 2. Glycol Cooling Supply and Return:
 - a. Cellular Glass or Phenolic Insulation:
 - 1) Pipe Size Range: Up to 1-1/2", 1-1/2 inch thickness.
 - 2) Pipe Size Range: 2" and over, 2 inch thickness.
 3. Condensate Drains from Cooling Coils:
 - a. Glass Fiber Insulation:
 - 1) All sizes, 1/2 inch thickness where concealed in a wall or ceiling space.

END OF SECTION 230719

SECTION 230800

COMMISSIONING OF HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. See Section 019113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 019113.
- 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 Authority (CA) 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. 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.

1.2 REFERENCE STANDARDS

- A. ASHRAE Guideline 1.1 - The HVAC Commissioning Process.

1.3 SUBMITTALS

- A. Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- C. 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. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.

2. Full as-built set of control drawings.
 3. Full as-built sequence of operations for each piece of equipment.
 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
 - a. Floor.
 - b. Room number.
 - c. Room name.
 - d. Air handler unit ID.
 - e. Reference drawing number.
 - f. Air terminal unit tag ID.
 - g. Heating and/or cooling valve tag ID.
 - h. Minimum air flow rate.
 - i. Maximum air flow rate.
 5. Full print out of all schedules and set points after testing and acceptance of the system.
 6. Full as-built print out of software program.
 7. Electronic copy on disk of the entire program for this facility.
 8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
 9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 10. Control equipment component submittals, parts lists, etc.
 11. Warranty requirements.
 12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
 13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation.
 - b. Control drawings.
 - c. Points lists.
 - d. Controller and/or module data.
 - e. Thermostats and timers.
 - f. Sensors and DP switches.
 - g. Valves and valve actuators.
 - h. Dampers and damper actuators.
 - i. Program setups (software program printouts).
- D. Project Record Documents: See Section 017700 for additional requirements.
- E. Draft Training Plan: In addition to requirements specified in Section 017900, include:
1. Follow the recommendations of ASHRAE Guideline 1.1.
 2. Control system manufacturer's recommended training.
 3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- F. Training Manuals: See Section 017900 for additional requirements.
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.1 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

3.1 PREPARATION

- A. Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.
- B. Furnish additional information requested by the Commissioning Authority.
- 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 Authority; update the schedule as appropriate.
- D. Notify the Commissioning Authority 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 Authority 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.

3.2 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 Authority 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.

3.3 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 Authority 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.

3.4 CONTROL SYSTEM 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 Authority.
- D. 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.
- E. 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.
- F. Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
 - 1. Setpoint changing features and functions.
 - 2. Sensor calibrations.
- G. Demonstrate to the Commissioning Authority:
 - 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. All control strategies and sequences not tested during controlled equipment testing.
- H. 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.

3.5 OPERATION AND MAINTENANCE MANUALS

- A. See Section 017700 for additional requirements.
- B. Add design intent documentation furnished by Engineer to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D. Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.6 DEMONSTRATION AND TRAINING

- A. See Section 017900 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 Authority during Functional Testing.
- D. Provide classroom and 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. Provide the following minimum durations of training:

- 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 230800

SECTION 230913

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Control panels.
- B. Control Valves:
 - 1. Ball valves with factory-mounted actuators.
 - 2. Globe valves with factory-mounted actuators.
 - 3. Butterfly valves with factory-mounted actuators.
 - 4. Electronic valve operators.
- C. Dampers.
- D. Damper Operators:
 - 1. Electric operators.
- E. Wall-, Surface-, and Duct-Mounted Sensors:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. Static air pressure sensors.
 - 4. Damper position indicators.
- F. Thermostats:
 - 1. Electric thermostats.
 - 2. Freezestats.
 - 3. Room-mount thermostat accessories.
 - 4. Immersion thermostats.
- G. Fan and pump motor run-status monitoring.
- H. Pipe-Mounted Sensors and Transmitters:
 - 1. Temperature sensors.
 - 2. Pressure transmitters.
 - 3. Differential pressure transmitters.
 - 4. Flow switches.

1.2 RELATED REQUIREMENTS

- A. Section 230519 - Meters and Gauges for HVAC Piping: Thermometer sockets and gauge taps.
- B. Section 232113 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, and gauge taps.

C. Section 232114 - Hydronic Specialties.

D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

A. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.

B. ANSI/FCI 70-2 - Control Valve Seat Leakage.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats.

E. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS

A. See Front End Specifications for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Project Record Documents: Record actual location of control components, including panels, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.6 WARRANTY

A. See Section 017700-Closeout Submittals for additional warranty requirements.

B. Correct defective work within a five year period after Substantial Completion.

PART 2 PRODUCTS

2.1 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.2 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

2.3 CONTROL VALVES

- A. Ball Valves with Factory-Mounted Actuators:
 - 1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc.
 - b. Johnson Controls International, PLC.
 - c. KMC Controls.
 - d. Schneider Electric.
 - e. Substitutions: See Section 016000 - Product Requirements.
 - 2. Service: Use for brine (30 percent glycol), chilled water, hot water, or steam at 15 to 25 psig (104.4 to 172.4).
 - 3. Replacements in Kind: Provide pressure-independent type.
 - 4. Rangeability: 500 to 1.
 - 5. ANSI Rating: Class 150.
 - 6. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
 - 7. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: NPT.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. 2-1/2 inches and Above:
 - 1) Connection Type: Flanged.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - c. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.

- 2) Ambient Side: From minus 4 to 122 degrees F.
- 8. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 0 to 10 VDC configured for proportional control.
 - c. Accessories: Provide with valve position indicator and manual override.
- B. Globe Valves with Factory-Mounted Actuators:
 - 1. Manufacturers:
 - a. Honeywell International, Inc.
 - b. Johnson Controls International, PLC.
 - c. Schneider Electric.
 - d. Belimo Aircontrols (USA), Inc..
 - e. Substitutions: See Section 016000 - Product Requirements.
 - 2. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.
 - 3. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
 - 4. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel.
 - c. Size for 3 psig maximum pressure drop at design flow rate.
 - d. Provide two-way valves with equal percentage characteristics and three-way valves with linear characteristics. Size two-way valve operators to close valves against pump shut-off head.
 - 5. Steam Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Replaceable plugs and seats of stainless steel. Pressure drop across any steam valve at maximum flow; as indicated on drawings.
 - c. Size for 10 psig inlet pressure and 5 psig pressure drop.
 - d. Valves shall have modified linear characteristics.
- C. Butterfly Valves with Factory-Mount Actuators:
 - 1. Manufacturers:
 - a. Honeywell International, Inc.
 - b. Johnson Controls International, PLC.
 - c. Schneider Electric.
 - d. Belimo Aircontrols (USA), Inc..
 - e. Substitutions: See Section 016000 - Product Requirements.
 - 2. Iron body, bronze disc, resilient replaceable seat for service to 180 degrees F wafer or lug ends, extended neck.
 - 3. Hydronic Systems:
 - a. Rate for service pressure of 125 psig at 250 degrees F.
 - b. Size for 1 psig maximum pressure drop at design flow rate.

D. Electronic Valve Actuators:

1. Valves shall fail in last position unless specified with a spring return per the sequence of operations. Where specified, the valve shall spring return to normal position as indicated on freeze, fire, or temperature protection.
2. Select operator for full shut-off at maximum pump differential pressure.

2.4 DAMPERS

- A. See Section 233300 for dampers and this section for actuators and operators.

2.5 DAMPER OPERATORS

A. General:

1. Provide actuators with torque capacity sized for minimum of 20 percent greater than maximum design stream velocity and hold tight seal against maximum system pressures.
2. Provide spring return for two position control and for fail safe operation.
3. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
4. Provide one operator for maximum 36 sq ft damper section.

B. Electric Operators:

1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.6 WALL-, SURFACE-, AND DUCT-MOUNT SENSORS

A. Temperature Sensors:

1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
3. Temperature Sensing Device: Compatible with project DDC controllers.

4. Performance Characteristics:

a. RTD:

- 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
- 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
- 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
- 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
- 5) Range: Minus 40 degrees F through 220 degrees F minimum.

b. Thermistor:

- 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
- 2) Range: Minus 25 degrees F through 122 degrees F minimum.

c. Temperature Transmitter:

- 1) Accuracy: 0.10 degree F minimum or plus/minus 0.20 percent of span.
- 2) Output: 4 to 20 mA.

- d. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - e. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
 - f. Ceiling and Recessed Mount Temperature Sensors: Ceiling-mounted sensor in a low-profile housing.
 - g. Room Temperature Sensors with Integral Digital Display:
 - 1) Construct for surface or wall box.
 - 2) Provide a four button keypad with the following capabilities:
 - (a) Indication of space and outdoor temperatures.
 - (b) Setpoint adjustment to accommodate room setpoint.
 - (c) Manual occupancy override and indication of occupancy status.
 - h. Temperature Averaging Elements:
 - 1) Use on duct sensors for ductwork 10 sq ft or larger.
 - 2) Use averaging elements where prone to stratification with sensor length 8 ft or 16 ft.
 - 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
 - i. Insertion Elements:
 - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
 - 2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B. Humidity Sensors, Outdoor-Mount:
- 1. Digitally profiled thin-film capacitive sensor encased in a die-cast metal, weather-proof plastic or metal housing with solar shield.
 - 2. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
 - 3. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
 - 4. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.
- C. Humidity Transmitters, Surface-Mounted:
- 1. Plastic housing encased, wall-mounted, humidity and temperature indicating sensor.
 - 2. Humidity Sensor Type: Thin-film capacitive.
 - 3. Accuracy: 1 percent at rated measuring scale and capable of withstanding 95 percent relative humidity without loss of calibration.
 - 4. Output: Two-wire, 4 to 20 mA, 0 to 5 VDC or 0 to 10 VDC, non-loop powered, selectable.
- D. Static-Air Pressure Sensors:
- 1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
 - 2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
 - 3. Accuracy: One percent of full scale with repeatability 0.3 percent.
 - 4. Output: 0 to 5 vdc with power at 12 to 28 vdc.
- E. Damper Position Indicators: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100 percent damper travel.

2.7 THERMOSTATS

A. Electric Thermostats:

1. Type: NEMA DC 3, 24 volts, with setback/setup temperature control.
2. Covers: Locking with set point adjustment, with thermometer.

B. Freezestats:

1. Configuration: Digital module tied to sensor-assembly.
2. Probe Sensing Length: 20 feet.
3. Setpoint Adjust Control: Slider with manual reset switch.
4. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
5. Mounting: Locate on cooling coil intake side.
6. Field Interface: Connect load line-voltage to starter.
7. Electrical Rating: Pilot duty, 125 VA at 125 to 600 VAC.

C. Room-Mounted Thermostat Accessories:

1. Thermostat Covers: Brushed aluminum.
2. Insulating Bases: For thermostats located on exterior walls.
3. Thermostat Guards: Metal mounted on separate base.
4. Adjusting Key: As required for device.
5. Aspirating Boxes: Where indicated for thermostats requiring flush installation.

D. Immersion Thermostats:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

2.8 FAN AND PUMP MOTOR RUN-STATUS MONITORING

A. Current Switches:

1. Mini Solid-Core: 2-State, On/Off digital output of motor status with adjustable trip point to detect belt loss or mechanical failure.
2. Maximum AC Current Monitoring Value: As indicated on drawings.

B. Differential Pressure Switches:

1. Fan Status: Select for adjustable range between 0 to 5 in-wc across fan discharge and external or fan inlet. Include static pressure tips.
2. Pump Status: Select for adjustable range between 8 to 60 psi across pump discharge and suction sides. Include static pressure tips and 3-way valve manifold.

2.9 PIPE-MOUNTED SENSORS AND TRANSMITTERS

A. Temperature Sensors:

1. Pipe-mounted temperature probe tied to weather-resistant enclosure for direct insertion into compatible liquids or gases or inserted into intermediary thermal grease-filled pipe-well compatible with interfaced fluid.
2. Sensor Type: 1,000 ohm Platinum RTD.
3. Transmitter: Fitted within probe-interface enclosure, calibrated.

- a. Monitoring Range: 32 to 122 degrees F, adjustable.
- b. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
- c. Accuracy: Plus/minus three percent. adjustable on the transmitter end.
4. Accessories: Provide downstream PT test plug and brass pipe-well.

B. Pressure Transmitters:

1. Self-contained transducer for monitoring of pneumatic, gas, liquid, or steam service with proportional range scaled over selected electronic output.
2. Service Monitoring Range: 0 to 15 psig.
3. Wetted Material: Brass for general service or stainless steel for steam and corrosive.
4. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.

C. Differential Pressure Transmitters:

1. General: Provide wet media differential pressure transducers with 6 ft (1.83 m) armored cable, to allow local or remote pressure sensing capability using existing plumbing runs.
 - a. Output: 3-wire transmitter; 4 to 20 mA, 0 to 5V, or 0 to 10V, selectable,
 - b. Sensor:
 - 1) Accuracy at 77 degrees F for less than or equal 20 ft:
 - (a) Ranges A and B: Plus/minus 1 percent F.S. typical.
 - 2) Long Term Stability: Plus/minus 0.25 percent.
 - 3) Zero Offset (Bidirectional and Port Swap Modes Only): 0.5 percent.
 - c. Operating Conditions:
 - 1) Sensor Operating Range: Minus 4 to 185 degrees F.
 - d. Enclosure: NEMA 250, Type 4.

D. Flow Switches:

1. Repetitive Accuracy: Plus/minus 10 percent of actual flow setting.
2. Switch Actuation: Adjustable over the operating range and sized for the application, such that the setpoint is between 25 and 75 percent of the full range.
3. Provide Form C snap-action contacts, rated for the application.
4. Furnish nonflexible paddle with magnetically actuated contacts, rated for service at a pressure greater than the installed conditions.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- D. Ensure installation of components is complementary to installation of similar components.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats; see Section 262726.
- C. Mount freeze protection thermostats using flanges and element holders.
- D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.
- E. Provide separable sockets for liquids and flanges for air bulb elements.
- F. Provide guards on thermostats in entrances and public areas.
- G. Provide valves with position indicators and with pilot positioners where sequenced with other controls.
- H. Provide mixing dampers of opposed blade construction arranged to mix streams. Provide pilot positioners on mixed air damper motors. Provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.
- I. Provide isolation (two-position) dampers of parallel blade construction.
- J. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
- K. Mount control panels adjacent to associated equipment on vibration free walls or free-standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- L. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
- M. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

END OF SECTION 230913

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SECTION 230923

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System description.
- B. Operator interface.
- C. Controllers.
- D. Power supplies and line filtering.
- E. System software.
- F. Controller software.
- G. HVAC control programs.
- H. Chiller control programs.

1.2 RELATED REQUIREMENTS

- A. Section 230913 - Instrumentation and Control Devices for HVAC.
- B. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks.
- B. MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests.
- C. NFPA 70 - National Electrical Code.
- D. UL (DIR) - Online Certifications Directory.

1.4 SUBMITTALS

- A. See Section 013300 – Submittal Procedures for submittal procedures.
- B. Product Data: Provide data for each system component and software module.
- C. Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. List connected data points, including connected control unit and input device.

3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 5. Indicate description and sequence of operation of operating, user, and application software.
- D. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.
 2. Include submittals data in final "Record Documents" form.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.6 WARRANTY

- A. See Section 017700-Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Substantial Completion.
- C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. The digital control system shall integrate into the existing campus wide DDC control system.
- B. Automatic temperature control field monitoring and control system using field programmable micro-processor based units.
- C. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- D. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

- E. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 230913.
- F. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- G. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.2 OPERATOR INTERFACE

- A. PC Based Work Station:
 - 1. Resides on high speed network with building controllers.
 - 2. Connected to server for full access to all system information.
- B. Workstation, controllers, and control backbone to communicate using BACnet protocol and addressing.
- C. BACnet protocol to comply with ASHRAE Std 135.

2.3 CONTROLLERS

- A. Building Controllers:
 - 1. General:
 - a. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.
 - b. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - c. Share data between networked controllers.
 - d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - e. Utilize real-time clock for scheduling.
 - f. Continuously check processor status and memory circuits for abnormal operation.
 - g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - h. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.

- 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B. Custom Application Controller:
- 1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.
 - f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- C. Application Specific Controllers:
1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
- D. Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 3. Binary Inputs:
 - a. Allow monitoring of On/Off signals from remote devices.

- b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
 - c. Sense dry contact closure with power provided only by the controller.
 4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.
 5. Analog Inputs:
 - a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
 - b. Compatible with and field configurable to commonly available sensing devices.
 6. Binary Outputs:
 - a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
 - b. Outputs provided with three position (On/Off/Auto) override switches.
 - c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.
 7. Analog Outputs:
 - a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
 - b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
 - c. Drift to not exceed 0.4 percent of range per year.
 8. Tri State Outputs:
 - a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
 - b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
 - c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.
 9. System Object Capacity:
 - a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
 - b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.4 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
2. Limit connected loads to 80 percent of rated capacity.
3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.

8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.5 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 19.2 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.6 SYSTEM SOFTWARE

A. Operating System:

1. Concurrent, multi-tasking capability.
 - a. Common Software Applications Supported: Microsoft Excel.
 - b. Acceptable Operating Systems
2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.

3. Custom Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
 4. Standard HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Chillers.
 - 2) Boilers.
 - 3) Air Handlers.
 - 4) Terminal HVAC Units.
 - 5) Fan Coil Units.
 - 6) Unit Ventilators.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Coils.
 - 4) Valves.
 - 5) Piping.
 - 6) Dampers.
 - 7) Ductwork.
 - c. File Format Compatible with Graphics Generation Package Program.
- B. Workstation System Applications:
1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.
 2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
 3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
 4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
 5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.

- f. All system security data stored in encrypted format.
- 6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
- 7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
- 8. Alarm Messages:
 - a. Descriptor: English language.
 - b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
- 9. Configurable Alarm Reactions by Workstation and Time of Day:
 - a. Logging.
 - b. Printing.
 - c. Starting programs.
 - d. Displaying messages.
 - e. Dialing out to remote locations.
 - f. Paging.
 - g. Providing audible annunciation.
 - h. Displaying specific system graphics.
- 10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
- 11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
- 12. Object, Property Status and Control:

- a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
13. Reports and Logs:
- a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.
 - 3) Archivable to hard disk.
 - b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
 - c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
 - d. Set to be printed on operator command or specific time(s).
14. Reports:
- a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.

- 3) Weather:
 - (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

C. Workstation Applications Editors:

1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
 - a. Configuration.
 - b. Name.
 - c. Control parameters.
 - d. Set-points.
4. Scheduling:
 - a. Monthly calendar indicates schedules, holidays, and exceptions.
 - b. Allows several related objects to be scheduled and copied to other objects or dates.
 - c. Start and stop times adjustable from master schedule.
5. Custom Application Programming:
 - a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
 - b. Programming Features:
 - 1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
 - 2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
 - 3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
 - 4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
 - 5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
 - 6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
 - 7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.
 - 8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.
 - 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.7 CONTROLLER SOFTWARE

- A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

- B. System Security:

1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C. Object or Object Group Scheduling:
1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 3. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.
 - b. Repeated annually.
 - c. Length of each period is operator defined.
- D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E. Alarms:
1. Binary object is set to alarm based on the operator specified state.
 2. Analog object to have high/low alarm limits.
 3. All alarming is capable of being automatically and manually disabled.
 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
 - 1) Print.
 - 2) Logged.
 - 3) Graphical displays.
- F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- G. Sequencing: Application software based upon specified sequences of operation in Section 230993.
- H. PID Control Characteristics:
1. Direct or reverse action.
 2. Anti-windup.
 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 4. User selectable controlled variable, set-point, and PED gains.
- I. Staggered Start Application:

1. Prevents all controlled equipment from simultaneously restarting after power outage.
2. Order of equipment startup is user selectable.

J. Energy Calculations:

1. Accumulated instantaneous power or flow rates are converted to energy use data.
2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

K. Anti-Short Cycling:

1. All binary output objects protected from short-cycling.
2. Allows minimum on-time and off-time to be selected.

L. On-Off Control with Differential:

1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Run-Time Totalization:

1. Totalize run-times for all binary input objects.
2. Provides operator with capability to assign high run-time alarm.

2.8 HVAC CONTROL PROGRAMS

A. General:

1. Support Inch-pounds and SI (metric) units of measurement.
2. Identify each HVAC Control system.

B. Optimal Run Time:

1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
4. Use outside air temperature to determine early shut down with ventilation override.
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.

2.9 CHILLER CONTROL PROGRAMS

A. Control function of condenser water reset, chilled water reset, and chiller sequencing. Support inch-pounds and SI (metric) units of measurement.

B. Condenser Water Reset: Automatically reset controlled condenser water temperature using measured outside wet bulb temperature and load being handled.

C. Chilled Water Reset: Automatically reset controlled chilled water temperature satisfying cooling coil requiring greatest cooling.

- D. Chiller Sequencing: Determine which combination of chillers will most efficiently satisfy chilled water load, by cycling chillers, based on comparing load to switchover limits defined for each chiller.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 230993.
- C. Provide conduit and electrical wiring in accordance with Section 260583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

3.4 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate complete and operating system to Owner.

3.5 MAINTENANCE

- A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
- B. Provide two complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

END OF SECTION 230923

SECTION 230934

VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.2 RELATED REQUIREMENTS

- A. Section 230529 - Hangers and Supports for HVAC Piping and Equipment.
- B. Section 230553 - Identification for HVAC Piping and Equipment: Identification products and requirements.
- C. Section 260526 - Grounding and Bonding.
- D. Section 260553 - Identification
- E. Section 262813 - Fuses.

1.3 REFERENCE STANDARDS

- A. IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code).
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- D. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
- E. NEMA ICS 7 - Industrial Control and Systems: Adjustable-Speed Drives.
- F. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.
- G. NEMA ICS 7.2 - Application Guide for AC Adjustable Speed Drive Systems.
- H. NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems.
- I. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- J. NEMA MG 1 - Motors and Generators.
- K. NFPA 70 - National Electrical Code.

- L. UL 98 - Enclosed and Dead-Front Switches.
- M. UL 508A - Industrial Control Panels.
- N. UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
 - 2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.
 - 3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
 - 5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Front End Specifications for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories. Shop drawings shall indicate the Short Circuit Current Rating (SCCR).
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Operation and Maintenance Data: NEMA ICS 7.1. Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
- F. Maintenance Materials: Furnish following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Air Filters: Two of each different type.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

- C. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABBe.
- B. Allen Bradley/Rockwell Automation.
- C. Danfoss Graham.
- D. Yaskawa.
- E. Square D.
- F. Substitutions: See Front End Specifications.
- G. Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.2 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B. Provide products listed, classified, and labeled as suitable for purpose intended.
- C. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- D. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
 - 1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
 - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 - 3. Motor nameplate data.
 - 4. Requirements for speed control range, speed regulation, and braking.

5. Motor suitability for bypass starting method, where applicable.
- E. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- F. Operating Requirements:
 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 3. Efficiency: Minimum of 96 percent at full speed and load.
 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
 5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- G. Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
 1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.
- H. Control System:
 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
 - 2) Vector Control: Provide selectable autotuning function.
 - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
 - c. Selectable braking control; DC injection or flux braking.
 - d. Adjustable minimum/maximum speed limits.
 - e. Adjustable pulse width modulation switching carrier frequency.
 - f. Adjustable motor slip compensation.
 - g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
 4. Status Indications:
 - a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.

- f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.
- 5. Protective Functions/Alarm Indications:
 - a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
- 6. Inputs:
 - a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
- 7. Outputs:
- 8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface.
 - a. Serial Communications: RS-485; support for BACnet MS/TP protocol.
 - b. Ethernet Communications: Support for Modbus TCP and BACnet IP protocol.
 - c. Remote Monitoring Capabilities:
 - 1) Motor run/stop status.
 - 2) Hand-off-auto status.
 - 3) Fault information.
 - 4) Discrete input/output status.
 - 5) Analog input/output values.
 - d. Remote Control Capabilities:
 - 1) Motor run/stop command.
 - 2) Hand-off-auto selection.
 - 3) Speed adjustment.
 - 4) Fault reset.
- 9. Features:
 - a. Password-protected security access.
 - b. Event log.
 - c. Remote monitoring and programming capability via web browser.
- I. Power Conditioning/Filtering:
 - 1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
 - 2. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- J. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
 - 1. Disconnects: Disconnect switch type.
 - a. Disconnect Switches: Fusible type with separate input fuses.

- b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 - 2. Provide door-mounted remote operator interface.
 - 3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
 - a. Bypass Method: Manual, unless otherwise indicated.
 - b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
 - c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
 - d. Overload Relays: Solid state or bimetallic thermal type.
 - 4. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
 - b. Packaged Controllers with Bypass:
 - 1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
 - 2) Motor Control Selector Switch: HAND/OFF/AUTO.
 - 3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
- K. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation under following service conditions without derating:
 - a. Altitude: Less than 3,300 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 - 2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- L. Short Circuit Current Rating:
 - 1. Provide controllers with listed short circuit current rating not less than 65,000 amperes.
 - 2. Provide line/input reactors where specified by manufacturer for required short circuit current rating.
- M. Conductor Terminations: Suitable for use with conductors to be installed.
- N. Enclosures:
 - 1. Comply with NEMA ICS 6.
 - 2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
 - 4. Cooling: Forced air or natural convection as determined by manufacturer.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:

1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Comply with NEMA ICS 2.
3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
4. Trip-free operation.
5. Visible trip indication.
6. Resettable:
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
7. Bimetallic Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.
 - b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - c. Trip test function.
8. Solid State Overload Relays:
 - a. Adjustable full load current.
 - b. Phase loss protection.
 - c. Phase imbalance protection.
 - d. Ambient temperature insensitive.
 - e. Thermal memory.
 - f. Trip test function.
 - g. Provide isolated alarm contact.

B. Fusible Disconnect Switches:

1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated or as required.
2. Fuse Clips: As required to accept indicated fuses.
3. Provide externally operable handle with means for locking in OFF position. Provide means for locking switch cover in closed position. Provide safety interlock to prevent opening of cover with switch in ON position with capability of overriding interlock for testing purposes.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.
- C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 230529.
- F. Install controllers plumb and level.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Install field-installed devices, components, and accessories.
- I. Provide fuses complying with Section 262813 for fusible switches as indicated.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.2 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.3 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.

END OF SECTION 230934

SECTION 232113

HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Chilled Water and Heat Pump piping, above grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, mechanical couplings, and dielectric connections.
- G. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
- H. Flow controls.

1.2 RELATED REQUIREMENTS

- A. Section 083100 - Access Doors and Panels.
- B. Section 099123 - Interior Painting.
- C. Section 230516 - Expansion Fittings and Loops for HVAC Piping.
- D. Section 230719 - HVAC Piping Insulation.
- E. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- E. ASME B31.9 - Building Services Piping.

- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- G. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- H. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- I. ASTM A536 - Standard Specification for Ductile Iron Castings.
- J. ASTM B32 - Standard Specification for Solder Metal.
- K. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- L. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- M. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- N. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- P. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- Q. AWWA C606 - Grooved and Shouldered Joints.
- R. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Indicate valve data and ratings.

1.5 QUALITY ASSURANCE

- A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- B. Welder Qualifications: Certify in accordance with ASME BPVC-IX.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 2. Use non-conducting dielectric connections whenever joining dissimilar metals.
 3. Make hydronic piping branch taps off of the top of the system mains.
 4. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Engineer.
 - b. Use rigid joints unless otherwise indicated.
 5. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 3. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
 4. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.2 HEATING WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.

- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
 3. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 4. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.3 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Threaded Joints (only allowed up to 2"): ASME B16.3, malleable iron fittings.
 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy. Braze all piping joints 2" and larger.
 2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.4 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
1. Threaded Joints: Galvanized cast iron, or ASME B16.3 malleable iron fittings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.5 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 7. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 8. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
 9. Vertical Support: Steel riser clamp.
 10. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 11. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 12. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 13. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 14. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 15. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
- C. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
1. Bases: High-density polypropylene.
 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 3. Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
 5. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

2.6 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe of 2 Inches and Less:
1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
1. Ferrous Piping: 150 psig forged steel, slip-on.
 2. Copper Piping: Bronze.
 3. Gaskets: 1/16 inch thick, preformed neoprene.

- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 - 4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 5. When pipe is field grooved, provide coupling manufacturer's grooving tools.
- D. Dielectric Connections:
 - 1. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.

2.7 BALL VALVES

- A. Manufacturers:
 - 1. Apollo Valves
 - 2. Victaulic Company
 - 3. Milwaukee Valve Company
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Up To and Including 2 Inches:
 - 1. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

2.8 BUTTERFLY VALVES

- A. Manufacturers:
 - 1. Crane Co.
 - 2. Milwaukee Valve Company
 - 3. Victaulic Company
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- D. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.
- E. Operator: 10 position lever handle.

2.9 SWING CHECK VALVES

- A. Manufacturers:
 - 1. Apollo Valves
 - 2. Milwaukee Valve Company
 - 3. Victaulic Company
 - 4. Substitutions: See Section 016000 - Product Requirements.
- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.
- C. Over 2 Inches:
 - 1. Iron body, bronze trim, stainless steel, bronze, or bronze faced rotating swing disc, renewable disc and seat, flanged or grooved ends.

2.10 SPRING LOADED CHECK VALVES

- A. Manufacturers:
 - 1. Crane Co.
 - 2. Milwaukee Valve Company
 - 3. Victaulic Company
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

2.11 FLOW CONTROLS

- A. Manufacturers:
 - 1. Griswold Controls
 - 2. Hays Fluid Controls
 - 3. ITT Bell & Gossett
 - 4. Taco, Inc.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.

- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems with specified fluid with corrosion inhibitors. See Section 232500 for additional requirements.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, glycol, chilled water, condenser water, heat pump water, and engine exhaust piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors and constructed of a minimum of 18 gauge sheetmetal. Provide schedule 40 pipe as sleeves with appropriate sealant at fire and/or smoke rated penetrations and pipe sleeve. Extend sleeves through floors a minimum of 2" above the floor. Wall sleeves shall be flush with the wall and chrome plated solid steel escutcheons shall be installed.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- H. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 230516.
- J. Grooved Joints:
 - 1. Install in accordance with the manufacturer's latest published installation instructions. All installations shall be done by factory-trained personnel. Contractor shall remove and replace any improperly installed products.
 - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
 - 3. Used grooved mechanical couplings and fasteners only in accessible locations.
- K. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

- L. Pipe Hangers and Supports:
1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 2. Support horizontal piping as scheduled.
 3. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 4. Place hangers within 12 inches of each horizontal elbow.
 5. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 8. Provide copper plated hangers and supports for copper piping.
 9. Prime coat exposed steel hangers and supports. See Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 230719.
- N. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083100 .
- O. Use eccentric reducers to maintain top of pipe level.
- P. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- Q. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. See Section 099123.
- R. Install valves with stems upright or horizontal, not inverted.
- S. Hydrostatically test all hydronic piping systems with 125 psi of water pressure for 24 hours.
- T. Testing of mechanical piping systems shall be witnessed by the Engineer. Provide a minimum of 24 hours notice prior to the testing.

3.3 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
1. 1/2 Inch, 3/4 Inch, and 1 Inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 2. 1-1/4 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 3. 1-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.

4. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.

END OF SECTION 232113

SECTION 232114
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Hydraulic separators.
- E. Strainers.
- F. Suction diffusers.
- G. Pressure-temperature test plugs.
- H. Automatic flow control valves.
- I. Relief valves.
- J. Glycol system.

1.2 RELATED REQUIREMENTS

- A. Section 232113 - Hydronic Piping.
- B. Section 232500 - HVAC Water Treatment: Pipe cleaning.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 EXPANSION TANKS

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC
 - 2. Amtrol Inc.
 - 3. Bell & Gossett, a brand of Xylem, Inc.
 - 4. Taco, Inc.
- B. Maximum Rated Working Pressure: 150 psi.
- C. Maximum Allowable Service Temperature: 240 degrees F.
- D. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible EPDM diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.
- E. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
- F. Accessories: Provide air-charging fitting, pressure gauge, and tank drain ball valve.

2.2 AIR VENTS

- A. Float Air Vent:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- B. Maximum Fluid Pressure: 150 psi.
- C. Maximum Fluid Temperature: 250 degrees F.

2.3 AIR SEPARATORS

- A. Coalescing Air/Dirt Separators:
 - 1. Manufacturers:
 - a. American Wheatley, a company of Global Flow Products, LLC
 - b. Bell & Gossett, a brand of Xylem, Inc.
 - c. Spirotherm, Inc.
 - d. Taco, Inc.

2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to top of separator.
5. End Connections: Class 150 flanged for 2-1/2 inch and larger otherwise threaded.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.
8. Maximum Fluid Service Pressure: 150 psi.
9. Maximum Fluid Service Temperature: 250 degrees F.

2.4 HYDRAULIC SEPARATORS

A. Hydraulic Separator/Buffer Tank:

1. Manufacturers:
 - a. American Wheatley, a company of Global Flow Products, LLC
 - b. Bell & Gossett, a brand of Xylem, Inc..
 - c. Taco, Inc..
2. Carbon-steel based, primer-base coated vertical-mounted buffer tank with flanged inlet-outlet pipe connections, and ASME BPVC-VIII-1 tested and stamped for maximum allowed operating pressure of 150 psi.
3. Threaded Connections: Aquastat, drain, and air vent. Provide aquastat, ball type drain valve, and air vent for field installation.

2.5 STRAINERS

A. Manufacturers:

1. American Wheatley, a company of Global Flow Products, LLC
2. Armstrong International, Inc.
3. Taco, Inc.
4. Victaulic Company
5. Substitutions: See Section 016000 - Product Requirements.

B. Size 2 inch and Under:

1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with integrated ball valve and stainless steel perforated screen as 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:

1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch or 3/64 inch stainless steel perforated screen.

D. Basket-Type, Size 1 to 30 inch for Liquid Service:

1. Flanged carbon steel body with 1/8 inch stainless steel perforated basket screen, bottom drain and capped air vent.
2. Fluid Service: Up to 285 psi at 100 degrees F.

E. Basket-Type, Size 2 to 24 inch for Steam and WOG Service:

1. Flanged cast iron body with 1/8 inch stainless steel perforated basket screen, and bottom drain.
2. Fluid Service:
 - a. Steam: Up to 125 psi at 350 degrees F.
 - b. Liquids: Up to 150 psi at 150 degrees F.

2.6 SUCTION DIFFUSERS

A. Manufacturers:

1. American Wheatley, a company of Global Flow Products, LLC
2. Bell & Gossett, a brand of Xylem, Inc.
3. Taco, Inc.
4. Victaulic Company of America

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.7 PUMP CONNECTORS

A. Manufacturers:

1. American Wheatley, a company of Global Flow Products, LLC
2. Anvil International; AnviFlex:
3. The Metraflex Company; Vane Flex

B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.

1. Maximum Operating Service: 150 psi at 120 degrees F.
2. Accommodate the Following:
 - a. Angular Rotation: 15 degrees.
 - b. Force developed by 1.5 times specified maximum allowable operating pressure.
3. End Connections: Same as specified for pipe jointing.
4. Provide pump connector with integral vanes to reduce turbulent flow.
5. Provide necessary accessories including, but not limited to, swivel joints.

2.8 PRESSURE-TEMPERATURE TEST PLUGS

A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.

B. Application: Use extended length plugs to clear insulated piping.

2.9 AUTOMATIC FLOW CONTROL VALVES

- A. Manufacturers:
 - 1. Armstrong International
 - 2. Bell & Gossett, a brand of Xylem, Inc.
 - 3. Hays Fluid Controls; Mesurflo Balancing Valve
 - 4. Taco Inc.
- B. Construction:
 - 1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
 - 2. Built-in lug-type outlet butterfly valve with 2-position handle.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- D. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.
- E. Size: Match system flow capacity.
- F. Accessories: Provide hanging tag, inlet in-line strainer, outlet ball valve, and PT test plug extension.

2.10 RELIEF VALVES

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC
 - 2. Armstrong International, Inc.
 - 3. Bell & Gossett, a brand of Xylem, Inc.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.11 GLYCOL SYSTEM

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC
 - 2. J.L. Wingert.
 - 3. Wessels.
- B. Pump System:
 - 1. Storage: 50 gal polypropylene tank with bolt-removable hinged solid cover and enamel coated carbon steel tank-stand.
 - 2. Pump:
 - a. Thermally protected motor at 115 to 120 VAC, single phase rated for indoor service.
 - b. Maximum Service Operation: 100 psi at 85 degrees F.
 - 3. Mechanical Accessories: System isolation valves, strainer, and pressure gauges.
 - 4. Control Panel:

- a. Fused single-point system connection rated at 115 to 120 VAC, single phase.
 - b. Interface: Hand switches with indicating lights for ON, FAULT, and LOW LEVEL.
 - c. Pressure Switch: Panel-mounted and prewired for 10 psi cut-in and 40 psi cut-out, adjustable.
 - d. Low Level Cut-Off Switch: Prewired to shut-down unit upon activation. Tank-side mounted.
 - e. Auxiliary Dry Contacts: Low level, high level, and fault/alarm for remote monitoring.
 - f. Alarm: Audio-visual device with panel-mounted silencing switch to activate upon system fault or alarm with audio pressure level rated for 90 dB.
5. Pressure Relief Valve: System-mounted brass valve tubed from pump discharge side into tank with adjustable setpoint between 20 psi and 150 psi.

C. Glycol Solution:

1. Water-based solution mix containing 35 percent propylene glycol by volume required for cooling or heating system operating temperature range.
2. Cooling or heating System Operating Temperature Range: Between freezing and boiling points of 3 and 220 degrees F at 14.7 psia.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Provide manual air vents at system high points and as indicated.
- C. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- D. Provide valved drain and hose connection on strainer blowdown connection.
- E. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- F. Support pump fittings with floor-mounted pipe and flange supports.
- G. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- H. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- I. Pipe relief valve outlet to nearest floor drain.
- J. Clean and flush glycol system before adding glycol solution, see Section 232500.
- K. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.

END OF SECTION 232114

SECTION 232123

HYDRONIC PUMPS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. In-line pumps.
- B. End-suction pumps.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete.
- B. Section 230513 - Common Motor Requirements for HVAC Equipment.
- C. Section 230923 - Direct-Digital Control System for HVAC.
- D. Section 230934 - Variable-Frequency Motor Controllers for HVAC.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code.
- B. UL 778 - Standard for Motor-Operated Water Pumps.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Armstrong Fluid Technology, Inc.
- B. Bell & Gossett, a Xylem Inc. brand.
- C. Grundfos Pumps Corporation.
- D. Taco, Inc.

2.2 GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Minimum Quality Standard: UL 778.
- C. Base Mounted Pumps: Aligned by qualified millwright.
- D. Electrical Requirements:
 - 1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
 - 2. Variable Frequency Drives (VFDs): Provide in accordance with Section 230934, except for integral-VFDs.
 - 3. Enclosures: Provide unspecified product(s) required to fit motor:

2.3 IN-LINE PUMPS

- A. Split-Coupled, Single-Stage Pump: Vertical pump with radially- or horizontally-split casing; rated for discharge pressures up to 175 psi.
- B. Casing: Cast iron with casing wear ring, seal flush connection, flanged suction, and discharge ports with gauge port and drain plug.
- C. Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- D. Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- E. Seal: Mechanical seal, 225 degrees F maximum continuous duty temperature.
- F. Electrical:
 - 1. Motor: 1,750 rpm, open drip-proof (ODP); see Section 230513.
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

2.4 END-SUCTION PUMPS

- A. Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.
- B. Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.
- C. Impeller: Bronze, balanced, fully enclosed, keyed to shaft.
- D. Bearings: Oil lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical, 225 degrees F maximum continuous duty temperature.

- G. Drive: Flexible coupling with coupling guard.
- H. Baseplate: Cast iron or fabricated steel with integral drain rim.
- I. Electrical:
 - 1. Motor: 1,750 rpm unless specified otherwise; see Section 230513.
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Provide line sized shut-off valve and pump suction fitting on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- D. Provide air cock and drain connection on horizontal pump casings.
- E. Provide drains for bases and seals, piped to and discharging into floor drains.
- F. Check, laser align, and certify alignment of base-mounted pumps prior to start-up.
- G. Install close-coupled and base-mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. See Section 033000.
- H. Lubricate pumps before start-up.
- I. Controls: Interface each pump starter or VFD with HVAC controller; see Section 230923.

END OF SECTION 232123

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SECTION 232213

STEAM AND CONDENSATE HEATING PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pipe and pipe fittings.
- B. Pipe hangers and supports.
- C. Steam piping system.
- D. Steam condensate piping system.

1.2 RELATED REQUIREMENTS

- A. Section 083100 - Access Doors and Panels.

1.3 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- D. ASME B31.1 - Power Piping.
- E. ASME B31.9 - Building Services Piping.
- F. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- H. ASTM B32 - Standard Specification for Solder Metal.
- I. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- K. AWS D1.1/D1.1M - Structural Welding Code - Steel.
- L. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.4 SYSTEM DESCRIPTION

- A. When more than one piping system material is selected, ensure systems components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Use unions and flanges downstream of valves and at equipment or apparatus connections. Use dielectric unions where joining dissimilar materials. Do not use direct welded or threaded connections.
- C. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- D. Use gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use ball or globe valves for throttling, bypass, or manual flow control services.

1.5 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labelling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Comply with ASME B31.9 and ASME B31.1 code for installation of piping system.
- B. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of welders.
- C. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.

2.2 LOW PRESSURE STEAM PIPING (15 PSIG MAXIMUM)

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M wrought steel.
 - 2. Joints: Threaded, or AWS D1.1/D1.1M welded.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 wrought copper.

2. Joints: Solder, lead free, ASTM B32, HB alloy (95-5 tin-antimony), or tin and silver.

2.3 LOW PRESSURE STEAM CONDENSATE PIPING

- A. Steel Pipe: ASTM A53/A53M, Schedule 80, black.
 1. Fittings: ASME B16.3 malleable iron Class 150, or ASTM A234/A234M wrought steel.
 2. Joints: Threaded, or AWS D1.1/D1.1M welded.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn.
 1. Fittings: ASME B16.18, cast brass, or ASME B16.22, wrought copper.
 2. Joints: Solder, lead free, ASTM B32, HB alloy (95-5 tin-antimony), or tin and silver.

2.4 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Hangers for Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- C. Hangers for Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
- D. Multiple or Trapeze Hangers for Pipe Sizes to 4 inches: Steel channels with welded spacers and hanger rods.
- E. Multiple or Trapeze Hangers for Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods; cast iron roll and stand.
- F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- G. Wall Support for Pipe Sizes 4 to 5 Inches: Welded steel bracket and wrought steel clamp.
- H. Wall Support for Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll.
- I. Vertical Support: Steel riser clamp.
- J. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
- L. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 Inches and Under:
 1. Ferrous Piping: 150 psig galvanized malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.

- B. Flanges for Pipe Over 2 Inches:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick preformed non-asbestos graphite fiber.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 EXECUTION

3.1 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. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction protect open ends with temporary plugs or caps.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- F. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 6. Provide copper plated hangers and supports for copper piping.
- G. Provide clearance for installation of insulation and access to valves and fittings.

- H. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 083100.
- I. Slope steam piping one inch in 40 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
- J. Slope steam condensate piping one inch in 40 feet. Provide drip trap assembly at low points and before control valves. Run condensate lines from trap to nearest condensate receiver. Provide loop vents over trapped sections.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- L. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 099123.
- M. Install valves with stems upright or horizontal, not inverted.

3.3 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Steam Piping.
 - 1. 1/2 inch: Maximum span, 8 feet; minimum rod size, 1/4 inch.
 - 2. 3/4 inch and 1 inch: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/4 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 4. 1-1/2 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 5. 2 inches: Maximum span, 13 feet; minimum rod size, 3/8 inch.
 - 6. 2-1/2 inches: Maximum span, 14 feet; minimum rod size, 3/8 inch.
 - 7. 3 inches: Maximum span, 15 feet; minimum rod size, 3/8 inch.
 - 8. 4 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
- C. Hanger Spacing for Steel Steam Condensate Piping.
 - 1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.

END OF SECTION 232213

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SECTION 232214

STEAM AND CONDENSATE HEATING SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.
- B. ASME B31.9 - Building Services Piping.
- C. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes.
- D. ASTM A351/A351M - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
- E. ASTM A743/A743M - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide for manufactured products and assemblies required for this project.
 - 2. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each specialty.
 - 4. Include electrical characteristics and connection requirements.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Iowa standard for installation of boilers and pressure vessels.
 - 1. Maintain one copy of each document on site.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 STEAM TRAPS

- A. Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. Marshall Engineered Products Company.
 - 3. Pennant.
 - 4. Spirax-Sarco.
- B. Inverted Bucket Traps: ASTM A126 cast iron or semi-steel body with bolted cover, brass bucket, stainless steel seats and plungers, and stainless steel lever mechanism with knife edge operating surfaces.
 - 1. Rating: 60 psi WSP.
 - 2. Features: Access to internal parts without disturbing piping, top test plug, bottom drain plugs.
- C. Float and Thermostatic Traps: ASTM A126 cast iron or semi-steel body and bolted cover, stainless steel or bronze bellows type air vent, stainless steel or copper float, stainless steel lever and valve assembly.
 - 1. Rating: 15 psi WSP.
 - 2. Features: Access to internal parts without disturbing piping, bottom drain plug.
- D. Thermodynamic Traps: Stainless steel body, disc, and cap.
 - 1. Features:
 - a. Stainless steel insulating cap.
 - b. 1/4 inch steel blow down valve.

2.2 STEAM AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. Bell and Gossett, a xylem brand.
 - 3. Spirax-Sarco.
- B. 125 psi WSP: Balanced pressure type; cast brass body and cover; access to internal parts without disturbing piping; stainless steel bellows, stainless steel valve and seat.

2.3 FLASH TANKS

- A. Manufacturers:
 - 1. Armstrong International Inc.
 - 2. Penn Separator Corporation.
 - 3. Wessels Company.
- B. Tank: Closed type, welded steel construction, cleaned, prime coated, and supplied with steel support legs.
 - 1. Tested and stamped in accordance with ASME BPVC-VIII-1.
 - 2. Working Pressure: 100 psi.
 - 3. Construct with nozzles and tapings for installation of accessories and piping connections.

2.4 LOW PRESSURE CONDENSATE RETURN UNITS

- A. Manufacturers:
 - 1. Bryan Steam Corporation.
 - 2. Marshall Engineered Products Company.
 - 3. Spirax-Sarco.
 - 4. Shipco.
- B. Condensate Return Units: Consist of receiver, inlet strainer, pumps, float switches, control panel and accessories.
- C. Condensate Receiver: Cast iron, equipped with externally adjustable float switches, water level gauge, dial thermometer, pressure gauges on pump discharge, bronze isolation valves between pumps and receiver, and lifting eye bolts.
- D. Inlet Strainer: Cast iron with vertical self-cleaning bronze screen and large dirt pocket, mounted on receiver. Screen shall be easily removable for cleaning.
- E. Pumps: Two stage, vertical design, bronze fitted with stainless steel shaft, bronze impeller, renewable bronze case ring, mechanical shaft seal, close coupled to 1750 rpm motor.
- F. Control Cabinet:
 - 1. NEMA 250 enclosure, UL listed, with piano hinged door, grounding lug, terminal strip, and fusible control circuit transformer.
 - 2. Combination magnetic starters with overload relays, circuit breakers and cover interlock.
 - 3. Electric alternator.
 - a. Operate pumps on high level, alternating after each cycle.
 - b. Operate second pump upon failure of first pump and alarm.
 - 4. 'Auto-Off' switch.
 - 5. Test button, high level alarm light, acknowledge button, alarm horn.

2.5 PRESSURE REDUCING VALVES

- A. Bronze or cast iron body, stainless or chrome steel valve spring, stem, and trim, phosphor bronze diaphragm, direct acting, threaded up to 2 inches, flanged over 2 inches.

2.6 SAFETY RELIEF VALVES

- A. Valve: Bronze body, stainless steel valve spring, stem, and trim, direct pressure actuated, capacities ASME certified and labelled.
- B. Accessories: Drip pan elbow.

2.7 CONTROL VALVES

- A. Materials:
 - 1. Valve Body: Carbon steel A216 Grade WCB.
 - 2. Bonnet: Carbon steel A216 Grade WCB.
 - 3. Valve/Valve Seat: 17-4 PH h900.
 - 4. Valve Spindle: Stainless steel, comply with ASTM A276/A276M, Type 431.
 - 5. Gland Packing:
 - a. Carbon filled V-Teflon, 450 degrees F.
 - b. Grafoil, 800 degrees F.
 - 6. Yoke: Ductile iron.
 - 7. Actuator Spring: Silicon chromium spring steel.
 - 8. Actuator Diaphragm: Nitrite reinforced with nylon fiber.
 - 9. Cage Material: Stainless steel CB30, comply with ASTM A743/A743M.
 - 10. Sealing Ring Material: Carbon filled V-Teflon.

2.8 CONNECTOR BLOCKS

- A. Connector Styles: 1/2 inch.
- B. Connection Types: Screwed NPT and BSPT or Socket weld.
- C. Materials:
 - 1. Connector Body: All 304 stainless steel, comply with ASTM A351/A351M.
 - 2. Strainer: 20 by 20 mesh 304 stainless steel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install steam and steam condensate piping and specialties in accordance with ASME B31.9.
- B. Install specialties in accordance with manufacturer's instructions.
- C. Steam Traps:
 - 1. Provide minimum 3/4 inch size on steam mains and branches.
 - 2. Install with union or flanged connections at both ends.
 - 3. Provide gate valve and strainer at inlet, and gate valve and check valve at discharge.
 - 4. Provide minimum 10 inch long, line size dirt pocket between apparatus and trap.
- D. Remove thermostatic elements from steam traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.

- E. Provide pressure reducing stations with pressure reducing valve, valved bypass, strainer and pressure gauge on upstream side, relief valve and pressure gauge on downstream side of pressure reducing valve.
 - 1. Pressure reducing station shall be one or two stages as required, to produce flat reduced pressure curve over range of capacity.
 - 2. Locate pilot operator control minimum 6 feet downstream of valve.
- F. Rate relief valves for pressure upstream of pressure reducing station, for full operating capacity. Set relief at maximum 20 percent above reduced pressure.
- G. Terminate relief valves to outdoors. Provide drip pan elbow with drain connection to nearest floor drain.
- H. When several relief valve vents are connected to a common header, header cross section area shall equal sum of individual vent outlet areas.

END OF SECTION 232214

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SECTION 232500

HVAC WATER TREATMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials.
 - 1. System cleaner.
 - 2. Closed system treatment (water).
 - 3. Steam system treatment.
- B. By-pass (pot) feeder.
- C. Water meter.
- D. Test equipment.

1.2 RELATED REQUIREMENTS

- A. Section 016000 - Product Requirements: Owner furnished treatment equipment.

1.3 REFERENCE STANDARDS

- A. UL (DIR) - Online Certifications Directory.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. AmSolv-Amrep, Inc.
- B. GE Water & Process Technologies.
- C. Nalco, an Ecolab Company.
- D. Fremont Industries.

2.2 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for addition of non-potable chemicals to building mechanical systems and to public sewage systems.
- B. Comply with UL (DIR) requirements.
- C. Perform work in accordance with local health department regulations.

2.3 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
- B. Closed System Treatment (Water):
 - 1. Product shall be registered by NSF for Nonfood Compounds as an acceptable water conditioner for the treatment of entire potable water systems at concentrations not to exceed 10 ppm calculated as phosphate ion in and around food processing areas.
 - 2. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 3. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium tolyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 - 4. Conductivity enhancers; phosphates or phosphonates.
- C. Steam System Treatment:
 - 1. Sequestering agent to reduce hardness and prevent feedline congestion; phosphate.
 - 2. Base to provide alkalinity; hydroxide.
 - 3. Oxygen scavenger; sodium sulphite or hydrazine.
 - 4. Carbon dioxide neutralizer; volatile amines such as morpholine or cyclohexylamine.
 - 5. Filming amines; octadecylamine.

2.4 BY-PASS (POT) FEEDER

- A. Manufacturers:
 - 1. Griswold Controls.
 - 2. J. L. Wingert Company.
- B. 2 quart quick opening cap for working pressure of 175 psi.

2.5 WATER METER

- A. Displacement type cold water meter with sealed, tamper-proof magnetic drive, impulse contact register, single pole, double throw dry contact switch.

2.6 TEST EQUIPMENT

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
- B. Provide the following test kits:
 - 1. Alkalinity titration test kit.
 - 2. Chloride titration test kit.
 - 3. Sulphite titration test kit.
 - 4. Total hardness titration test kit.
 - 5. Low phosphate test kit.
 - 6. Conductivity bridge, range 0 - 10,000 micro-ohms.
 - 7. Creosol red pH slide complete with reagent.
 - 8. Portable electronic conductivity meter.
 - 9. High nitrite test kit.

PART 3 EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, flushed, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by manufacturer.
- B. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- C. Chilled Water Systems:
 - 1. Circulate for 48 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.

D. Steam Systems:

1. Apply heat, slowly raising boiler temperature to 160 degrees F and maintain for 12 hours minimum.
2. Cool, then drain as quickly as possible.
3. Refill with clean water, drain, refill and check for sludge.
4. Repeat until system is free of sludge.
5. Apply heat to produce steam for piping system and maintain for 8 hours minimum. Bypass traps and waste condensate.

E. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.

F. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.

G. Remove, clean, and replace strainer screens.

H. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

3.4 CLOSED SYSTEM TREATMENT

A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

B. Introduce closed system treatment through bypass feeder when required or indicated by test.

3.5 STEAM SYSTEM TREATMENT

A. Provide bypass feeder on feed water line to each boiler.

B. Activate solution pumps when feed water pumps are running.

C. Provide conductivity controller to sample boiler water and operate solenoid blowdown valve. Provide timer activated sampling with solenoid valve, balancing valve, and conductivity probe. Pipe to blowdown tank.

D. Provide 3/4 inch water coupon rack on each feed water pump with space for 4 test specimens.

E. Provide liquid level switch in each solution tank to deactivate solution pump and agitator and sound local alarm bell.

3.6 CLOSEOUT ACTIVITIES

A. Training: Train Owner's personnel on operation and maintenance of chemical treatment system.

1. Provide minimum of two hours of instruction for two people.

2. Have operation and maintenance data prepared and available for review during training.
3. Conduct training using actual equipment after treated system has been put into full operation.

3.7 MAINTENANCE

- A. Perform maintenance work using competent and qualified personnel under the supervision and in the direct employ of the equipment manufacturer or original installer.
- B. Provide service and maintenance of treatment systems for one year from Date of Substantial Completion.
- C. Provide monthly technical service visits to perform field inspections and make water analysis on-site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
- D. Provide laboratory and technical assistance services during this maintenance period.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

3.8 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
 1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational.
 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
- B. Initial Start-up Service - At no additional cost to the owner, a factory representative shall set up the blow-down system. An Initial Start-up Service report shall be provided to the operator.

END OF SECTION 232500

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SECTION 233100

HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ducts.
- B. Flexible ducts.

1.2 RELATED REQUIREMENTS

- A. Section 230713 - Duct Insulation: External insulation and duct liner.
- B. Section 233319 - Duct Silencers.

1.3 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- G. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- H. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- I. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- J. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- K. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for duct materials.

- C. Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration prior to start of work for duct systems.
- D. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
- E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

1.6 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A, NFPA 96, and SMACNA (DCS) guidelines unless stated otherwise.
- B. Acoustical Treatment: Provide sound-absorbing liners and sectional silencers for metal-based ducts in compliance with Section 233319.
- C. Duct Sealing and Leakage in accordance with Static Pressure Class:
 - 1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:
 - a. Supply Air: 2 in-wc (500 Pa) positive pressure class, galvanized steel.
 - b. Primary Supply Duct (before Air Terminal Units): 4 in-wc (1000 Pa) positive pressure class, galvanized steel.
 - c. Secondary Supply Duct (after Air Terminal Units): 2 in-wc (500 Pa) positive pressure class, galvanized steel.
 - d. Outside Air Intake: 1 in-wc 2 in-wc (500 Pa) negative pressure class, galvanized steel.
 - e. Return and Relief Air: 2 in-wc (500 Pa) negative pressure class, galvanized steel.
 - f. General Exhaust Air: 2 in-wc (500 Pa) negative pressure class, galvanized steel.
 - g. Transfer-air and Sound Boots: 1 in-wc pressure class, galvanized steel.
 - h. Wet Exhaust Ducts: 2 in-wc (500 Pa) negative pressure class, aluminum.
 - 2. Low Pressure Service: Up to 2 in-wc:
 - a. Seal: Class C, apply to seal off transverse joints.
 - b. Leakage:
 - 1) Rectangular: Class 24 or 24 cfm/100 sq ft.
 - 2) Round: Class 12 or 12 cfm/100 sq ft.

3. Low Pressure Service: From 2 in-wc to 3 in-wc:
 - a. Seal: Class B, apply sealing of transverse joints and longitudinal seams.
 - b. Leakage:
 - 1) Rectangular: Class 12 or 12 cfm/100 sq ft.
 - 2) Round: Class 6 or 6 cfm/100 sq ft.
 4. Medium and High Pressure Service: Above 3 in-wc:
 - a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.
 - b. Leakage:
 - 1) Rectangular: Class 6 or 6 cfm/100 sq ft.
 - 2) Round: Class 3 or 3 cfm/100 sq ft.
- D. Duct Fabrication Requirements:
1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
 4. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 5. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.2 METAL DUCTS

A. Material Requirements:

1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
2. Aluminum: ASTM B209/B209M, aluminum sheet, alloy 3003-H14.
3. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
4. Stainless Steel: ASTM A666, Type 304.

B. Flat-Oval Metal Ducts:

1. Flat-Oval Single Wall Duct: Machine made from a round spiral lock seam duct.
 - a. Fittings: Manufacture at least two gauges heavier metal than the duct.
 - b. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
2. Flat-Oval Double Wall Insulated Duct: Machine made from round spiral lock seam duct.
 - a. Fittings: Manufacture with solid inner wall.
 - b. Inner Wall: Perforated galvanized steel.
 - c. Insulation: See 230713 - Duct Insulation.

C. Round Metal Ducts:

1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.

2. Round Double Wall Insulated Duct: Round spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
 - a. Insulation: See 230713 - Duct Insulation.
3. Round Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

D. Round Spiral Duct:

1. Round spiral lock seam duct with galvanized steel outer wall.
2. Fittings: Manufacture at least two gauges heavier metal than the duct.
3. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

E. Connectors, Fittings, Sealants, and Miscellaneous:

1. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - b. VOC Content: Not more than 250 g/L, excluding water.
 - c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - d. For Use with Flexible Ducts: UL labeled.
2. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.3 FLEXIBLE DUCTS

A. Flexible Air Ducts:

1. UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
2. Pressure Rating: From 10 in-wc to 1 in-wc negative.
3. Temperature Range: Minus 20 to 210 degrees F.

2.4 WATERPROOFED DUCTWORK

- A. All ductwork mentioned below shall be constructed of material listed in DUCT ASSEMBLIES section and all joints shall be taped and sealed with Hardcast to assure an air and watertight joint on all fittings and duct connections. Hardcast shall be installed in strict conformance with manufacturer's recommendations. Clean duct thoroughly of oil or any foreign substances of Hardcast may not adhere.
1. All fresh air ducts from HVAC equipment to the exterior louvers/hoods.
 2. All exhaust ductwork from the exterior louver/hood to the heat recovery unit.
 3. All duct from the dishwasher outlet/exhaust grille to where it connects to the main exhaust duct.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install products following the manufacturer's instructions.
- C. Provide all ductwork offsets and fittings as required for a quality installation.
- D. Comply with safety standards NFPA 90A and NFPA 90B.
- E. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- F. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- G. Flexible Ducts: Connect to metal ducts with liquid adhesive plus tape.
- H. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- I. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
- J. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- K. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- L. Connect diffusers or light troffer boots to low-pressure ducts with 3 feet maximum length of flexible duct held in place with strap or clamp.
- M. For installation of exposed spiral ductwork, hang with stainless steel braided cable system or as detailed otherwise on the Drawings.
- N. Seal all supply duct connections to heat pumps, air handling units, fan coils, furnaces, etc.
- O. At exterior wall louvers, seal duct to louver frame. See detail on drawings.

END OF SECTION 233100

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SECTION 233300

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices.
- B. Backdraft dampers - metal.
- C. Combination fire and smoke dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Smoke dampers.
- I. Volume control dampers.
- J. Low leakage (Class 1A) control dampers.
- K. Miscellaneous Products:
 - 1. Duct opening closure film.
 - 2. High Efficiency Takeoff.

1.2 RELATED REQUIREMENTS

- A. Section 233100 - HVAC Ducts and Casings.
- B. Section 233600 - Air Terminal Units: Pressure regulating damper assemblies.
- C. Section 253513 - Integrated Automation Actuators and Operators: Damper operators.
- D. Section 253516 - Integrated Automation Sensors and Transmitters: Damper position switch.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- B. NFPA 92 - Standard for Smoke Control Systems.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service.
- F. UL 555 - Standard for Fire Dampers.
- G. UL 555S - Standard for Smoke Dampers.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
- C. Project Record Drawings: Record actual locations of access doors and test holes.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES

- A. Manufacturers:
 - 1. Carlisle HVAC Products.
 - 2. Ductmate Industries, Inc.
 - 3. Duro Dyne Corp.
 - 4. Elgen Manufacturing Company, Inc..
 - 5. Metalaire, Inc.
- B. Turning vanes and vane runners shall be fabricated to comply with SMACNA standards. Vane runners shall automatically align vanes.
- C. Manufactured Turning Vanes: Fabricate single-wide curved blades of galvanized steel, aluminum, or stainless steel, to match duct material; support with bars perpendicular to blades set 2 inches on center; and set into vane runners suitable for duct mounting.
- D. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill. Provide only where noted on plan.

2.2 BACKDRAFT DAMPERS - METAL

- A. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.

- B. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc.
 - 2. Pottorff.
 - 3. Ruskin Company.
 - 4. Greenheck.
- B. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C. Provide factory sleeve and collar for each damper.
- D. Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labeled; spring-return, electric-type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on exterior of duct and link to damper operating shaft.
- F. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.4 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Nailor Industries, Inc..
 - 2. Ruskin Company.
 - 3. Greenheck.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
- D. Access doors with sheet metal screw fasteners are not acceptable.

2.5 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.6 FIRE DAMPERS

A. Manufacturers:

1. Nailor Industries, Inc.
2. Pottorff.
3. Ruskin Company.
4. Greenheck.

B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.

C. Ceiling (Radiation) Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame and 16-gauge, 0.0598-inch flap, two layers of 0.125-inch thick ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.

D. Horizontal Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame, stainless steel closure spring, and lightweight, heat-retardant, non-asbestos fabric blanket.

E. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch pressure-class ducts up to 12 inches in height.

F. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

2.7 FLEXIBLE DUCT CONNECTORS

A. Fabricate in accordance with SMACNA (DCS) and as indicated.

B. Flexible Duct Connections: Fabric crimped into metal edging strip.

1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd.
 - a. Net Fabric Width: Approximately 2 inches wide.

2.8 SMOKE DAMPERS

A. Manufacturers:

1. Nailor Industries, Inc.
2. Pottorff.
3. Ruskin Company.
4. Greenheck.

B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

C. Dampers: UL Class 1 airfoil blade type smoke damper, normally closed automatically operated by electric actuator. Provide actuator outside of airstream is possible or confirm proper access is available.

D. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.9 VOLUME CONTROL DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc..
 - 2. Pottorff.
 - 3. Ruskin Company.
 - 4. Greenheck.
- B. Fabricate in accordance with SMACNA (DCS) and as indicated.
- C. Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 6 by 30 inch.
 - 2. Round single blade dampers shall have rolled stiffener blades with a firm, closed-cell neoprene seal at damper edges. Leakage shall not exceed 0.15 cfm per inch of blade circumference at a pressure difference of 4" w.g.
- D. Multi-Blade Damper: Fabricate consisting of opposed blades with maximum blade sizes 8 by 72 inches. Assemble center- and edge-crimped blades in prime-coated or galvanized-channel frame with suitable hardware.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.
- F. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.10 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

- A. Manufacturers:
 - 1. Ruskin Company; CD50.
 - 2. Greenheck.
- B. Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.
- C. Frame:
 - 1. Material: 20-gauge galvanized steel.
 - 2. Free-area: Single cross section.
- D. Blade:
 - 1. Type: Multi-blade such as V or 3V for low to medium pressure.
 - 2. Operation: Opposed type.
 - 3. Material: 12-gauge galvanized steel.
 - 4. Authority: Opposed type, 5 to 50 percent (typically 10 percent).
- E. Insulation: Water-resistant sound absorbing material.

- F. Temperature Service Range: Minus 25 to 185 degrees F.

2.11 MISCELLANEOUS PRODUCTS

- A. Damper Operators: Provide electric operators; low-voltage for integration into the controls system, unless noted otherwise.
- B. Damper position switch; only where required on plans.
- C. Duct Opening Closure Film: Mold-resistant, self-adhesive film to keep debris out of ducts during construction.
 - 1. Thickness: 2 mils.
- D. High Efficiency Takeoff: Die stamped galvanized round duct takeoff with damper, operator rod gasket, flange gasket, and 2" operator standoff to allow for insulation. Sheetmetal Connectors Super HETO.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 233100 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size access door for hand and shoulder access, or as indicated on drawings. Provide minimum 4 by 4 inch size access door for balancing dampers only. Review locations prior to fabrication.
- D. Provide duct test holes where indicated and required for testing and balancing purposes.
- E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- G. Demonstrate re-setting of fire dampers to Owner's representative.
- H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.
- I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

- J. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.
- K. Provide balancing dampers in air systems where indicated.
- L. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- M. Install high efficiency takeoffs (HETO's) as shown on drawings on round supply duct connections to rectangular duct mains. Seal flange connections and all joints with duct sealant.
- N. Install turning vanes in all square elbows, except for in the following duct systems: grease exhaust, combustion air, and dryer vents.

END OF SECTION 233300

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SECTION 233700

AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Diffusers
- B. Registers/grilles

1.2 RELATED REQUIREMENTS

- A. Section 099123 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.3 REFERENCE STANDARDS

- A. AHRI 880 (I-P) - Performance Rating of Air Terminals.
- B. SMACNA (ASMM) - Architectural Sheet Metal Manual.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 SEE DRAWINGS FOR REGISTERS, GRILLES, AND DIFFUSERS SCHEDULE

2.2 MANUFACTURERS

- A. Krueger-HVAC.
- B. Nailor Industries, Inc.
- C. Price Industries.
- D. Titus, a brand of Air Distribution Technologies.
- E. Tuttle and Bailey.

2.3 VAV DIFFUSERS

- A. General:

1. Factory-assembled, AHRI 880 (I-P) rated, variable air volume control terminal with damper/actuator assemblies, temperature sensors, duct collars, and required features.
 2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits.
 3. Provide square and linear diffusers as indicated on drawings.
 4. Each VAV diffuser to have a temperature adjustment scale with indicators that range from 70 degrees F to 78 degrees F.
 5. Room temperature settings for heating and cooling to be separately adjustable.
 6. Each VAV diffuser will be capable of adjusting minimum airflow from 0 to 30 percent.
 7. Each VAV diffuser to be self-contained and self-powered.
- B. Construction:
1. Minimum 24 gauge, 0.0239 inch galvanized steel.
 2. Air Inlet Collars: Provide round, suitable for standard flexible duct sizes.
- C. Damper Assembly:
1. Provide room temperature sensing, thermal actuators to control cone-shaped diffusion damper.
 2. Incorporate low leak damper blades for tight airflow shutoff.
- D. Controls:
1. Room Sensor:
 - a. Wall-mounted, compatible with temperature controls specified.
 - b. Provide with temperature set-point adjustment.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.
- E. Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black, see Section 099123.

3.2 PROTECTION

- A. Protect installed products until completion of project.
- B. Replace, repair, or touch-up damaged products before Substantial Completion.

END OF SECTION 233700

SECTION 235700

HEAT EXCHANGERS FOR HVAC

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Shell and tube type heat exchangers.
- B. Plate type heat exchangers.
- C. Accessories and trim.

1.2 RELATED REQUIREMENTS

- A. Section 232114 - Hydronic Specialties.
- B. Section 232214 - Steam and Condensate Heating Specialties.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide data with dimensions, locations, and size of tappings and performance data.
- C. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Gaskets: One set of each type and size.
 - 2. Plate Type Heat Exchanger Tools: One set of wrenches for disassembly.

1.5 WARRANTY

- A. See Section 017700-Closeout Submittals for additional warranty requirements.
- B. Provide five year manufacturer warranty.

PART 2 PRODUCTS

2.1 SHELL AND TUBE TYPE HEAT EXCHANGER

- A. Manufacturers:
 - 1. American Wheatley, a company of Global Flow Products, LLC.

2. Armstrong Pumps Inc.
3. Bell & Gossett, a xylem brand.
4. Taco, Inc.

- B. Heat Transfer Configuration: Heating fluid in shell and heated fluid within tubes.
- C. Type: Steam to liquid, two-pass, flanged straight tube path assembly.
- D. Water Chamber and Tube Bundle: Removable type for inspection and cleaning.
- E. Comply with ASME BPVC-VIII-1 for manufacture of tubular heat exchangers and heat exchanger shells.
- F. Maximum Service Temperature: 375 degree F on shell and tube sides.
- G. Tubes: U-tube type with 3/4 inch OD minimum seamless copper tubes suitable for 125 psi working pressure.
- H. Tubes: Straight tube type with 3/4 inch OD minimum seamless copper tubes suitable for 125 psi working pressure.
- I. Shell: Steel pipe with threaded or flanged piping connections and necessary tappings, steel saddle and attaching U-bolts, prime coated.
- J. Heads: Cast iron or fabricated steel with steel or bronze tube sheets, threaded or flanged for piping connections.

2.2 PLATE AND FRAME TYPE HEAT EXCHANGER

- A. Manufacturers:
 1. Alfa Laval.
 2. Armstrong Pumps Inc.
 3. Bell & Gossett, a Xylem brand.
 4. Taco, Inc.
- B. Comply with ASME BPVC-VIII-1 for manufacture of plate and frame type heat exchangers.
- C. Frames: Carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
- D. Plates: Stainless steel Type 304.
- E. Gaskets: Nitrile rubber.
- F. Nozzles: 125 psi rated lined flange type.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install to permit removal of plates with minimum disturbance to installed equipment and piping.

- C. Support heat exchangers on concrete housekeeping pad.
- D. Pitch shell to completely drain condensate.
- E. Pipe relief valves to nearest floor drain.
- F. Pipe drain valves to nearest floor drain.

3.2 STEAM TO WATER HEAT EXCHANGER TRIM

- A. Shell: Pressure gauge tapping with pigtail siphon, vacuum breaker; see Section 232214.
- B. Water Inlet: Thermometer well, pressure gauge tapping, valved drain; see Section 232114.
- C. Water Outlet: Thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, thermometer well, pressure gauge tapping; see Section 232114.

3.3 WATER TO WATER HEAT EXCHANGER TRIM

- A. Water Inlets and Outlets: Thermometer wells, pressure gauge tapplings.
- B. Heated Water Outlet: Thermometer well for temperature regulator sensor, ASME rated pressure and temperature relief valve, valved drain; see Section 232114.

3.4 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect the exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

END OF SECTION 235700

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SECTION 236423

SCROLL WATER CHILLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water-cooled scroll water chillers.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete housekeeping pads.
- B. Section 230593 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 230800 - Commissioning of HVAC.
- D. Section 230993 - Sequence Of Operations for HVAC Controls.
- E. Section 232113 - Hydronic Piping.
- F. Section 232114 - Hydronic Specialties.
- G. Section 253519 - Integrated Automation Control Valves.
- H. Section 260583 - Wiring Connections.

1.3 REFERENCE STANDARDS

- A. AHRI 550/590 (I-P) - Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems.
- C. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels.
- E. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. UL 1995 - Heating and Cooling Equipment.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Engineer of any major deviations from the equipment originally specified prior to ordering equipment.

1.5 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- D. Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.
- E. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. When required, provide certification of inspection in compliance with the requirements of Authority Having Jurisdiction.

1.7 WARRANTY

- A. See Section 017700-Closeout Submittals for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials and labor for compressor.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Carrier Corporation.
- B. ChillMaster.
- C. Daikin Applied Americas, Inc.
- D. Trane Technologies.
- E. WaterFurnace International, Inc.
- F. York, a brand of Johnson Controls International, PLC.
- G. Substitutions: See Section 016000 - Product Requirements.
 - 1. The chilled water system has been designed based on specific capacities and characteristics of equipment specified in this section and other sections.

2. When substitution of a different manufacturer or model number is desired, submit sufficient information to demonstrate to Engineer that the substitute will have the same or better performance as that specified AND that the related equipment in the system will perform acceptably with the substitute.
3. If the related equipment must be modified to perform acceptably with the substitute, the entity proposing the substitution is responsible for all additional costs due to re-design and provision of different related equipment.

2.2 , SCROLL WATER CHILLER

- A. Factory assembled and tested chiller consisting of compressor(s), compressor motor(s), evaporator, condenser, enclosure, refrigeration circuits(s) and specialties, interconnecting piping, starters, and microprocessor-based controls.
 1. Rating: AHRI 550/590 (I-P).
 2. Safety: UL 1995 and ASHRAE Std 15.
 3. Construction and Testing: ASME BPVC-VIII-1 as applicable for construction type.
 4. Enclosures:
 - a. Frame: Heavy-gauge steel with hot-dipped galvanized or air-dried paint finish.
 - b. Steel Cabinets: Factory apply baked on enamel or baked on powder paint finish.
 - c. Perform 500-hour minimum salt spray test in accordance with ASTM B117.
- B. Hermetic Scroll Compressor:
 1. Unit: Fully hermetic type with multiple, direct drive compressors with discharge and suction service valves.
 2. Vibration Control: Factory installed internal isolators or field installed external isolators.
 3. Oil Lubrication System: Initial oil charge, oil sump, heater, oil level, and sight glass.
 4. Capacity Reduction System: Compressor staging with control down to 12 percent of full load without the activation of hot gas bypass.
 5. Motor: 3600 or 3500 rpm, suction gas-cooled, with thermal or current overload protection.
- C. Evaporator:
 1. Brazed plate type.
 - a. Plate Material: 316 stainless steel.
 - b. Working Pressure Rating, Refrigerant Side: 430 psi minimum.
 - c. Working Pressure Rating, Water Side: 150 psi minimum.
 - d. End Connections: Provide with flanged or grooved connections.
 - e. Cold Surface Insulation.
 - 1) Insulation is factory or field installed on evaporator, connections, and suction piping.
 - 2) 0.75 inches minimum thick, closed cell, expanded polyvinyl chloride, polyurethane, or Armaflex II insulation with a maximum K factor of 0.28.
 - f. Provide factory installed vents and water drain connections on evaporator or piping.
 - g. Provide factory installed fittings for temperature control sensors on evaporator or piping.
 - h. Freeze Protection for Outdoor Locations: Provide thermostatically controlled electric heater to protect from freezing at ambient temperatures down to minus 20 degrees F.
- D. Water-Cooled Condenser, Brazed Plate Type:

1. Brazed plate type.
 - a. Plate Material: 316 stainless steel.
 - b. Working Pressure Rating, Refrigerant Side: 505 psi minimum.
 - c. Working Pressure Rating, Water Side: 300 psi minimum.
 - d. End Connections: Provide with flanged or grooved connections.
- E. Air-Cooled Condenser, Finned-Tube Type:
 1. Finned-Tube Type:
 - a. Mechanically bond aluminum fins to copper tubing and protect with corrosion resistant materials or coatings.
 - b. Clean, dehydrate and test.
 - c. Leak Test: 650 psi minimum.
 2. Coil Guards: Provide corrosion proof, louvered panels, heavy gauge wire panels, or grilles, factory installed. Protect condenser coil by enclosing with heavy plastic to prevent damage during shipping or rigging.
 3. Fans and Motors:
 - a. Fans: Dynamically balance propeller, shrouded-axial, or airfoil type fans of reinforced polymer or glass fiber reinforced composite corrosion resistant construction equipped with sealed, permanently lubricated ball bearings.
 - b. Discharge Fan Guards: Corrosion resistant, heavy gauge, steel wire.
 - c. Discharge Direction: Vertical.
 - d. Motors: Direct drive, totally enclosed for outdoor use with current overload protection.
- F. Refrigerant Circuits:
 1. Provide multiple independent refrigeration circuits with one or multiple compressor(s) per circuit.
 2. Provide liquid line shut-off valve, filter-drier, expansion valve, and refrigerant relief device for each independent circuit.
- G. Controls Package:
 1. Unit Controls: Factory-supplied DDC:
 - a. Control-panel mounted with required input-output expansions, power supply, fused disconnect, hand switches, knobs, and accessories required to control chiller unit to manufacturer required sequences to meet intended use with listed performance.
 - b. Factory configured to interface prewired sensors, switches, and safeties with allowance to add up to four chiller valves and flow sensors.
 - c. Graphic-based touchscreen to include unit operation controls and user filter based interface for faults, alarms, performance, unit diagnostics, and data recording up to 12 months.
 - d. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
 - e. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.
 - f. Isolation Valves: Field-installed, 2-position, butterfly type with position tracking; see Section 253519.

2. Prewire, assemble, factory mount, and test operating and safety control system consisting of a digital display or gauges, on-auto-off switch, motor starters, disconnect switches, power and control wiring. Provide controls, monitoring, programmable setpoints, alarms, and BAS as defined below:
 - a. Automatic Adjustable Operating Controls:
 - 1) Temperature of chilled water leaving chiller.
 - 2) Chiller system capacity control based on setpoints and system load.
 - 3) Compressor short-cycling prevention.
 - 4) Lead/lag for multiple compressors.
 - 5) Automatic reset on power source failure.
 - 6) Load limiting.
 - b. Normal Operation Monitoring and Open Coverless Displays:
 - 1) Hours of operation.
 - 2) Suction and discharge refrigerant pressures.
 - 3) Automatic diagnostics.
 - 4) Number of starts.
 - 5) On/off compressor status.
 - 6) Entering and leaving chilled water temperatures.
 - 7) Status of operation.
 - 8) Condenser water entering and leaving temperatures.
 - 9) Weekly purge cycle totalization if applicable.
 - 10) Oil pressure.
 - c. Setpoints:
 - 1) Leaving chilled water temperature.
 - 2) Date/time.
 - d. Automatic Chiller Shut-Down Safety Controls and Alarm:
 - 1) Automatic Reset:
 - (a) Chilled water flow interlock.
 - (b) Voltage protection; over and under.
 - (c) Phase reversal protection.
 - 2) Manual Reset:
 - (a) Evaporator low pressure.
 - (b) High motor winding temperature.
 - (c) Low chilled water temperature.
 - (d) Low chilled water flow.
 - (e) High condenser refrigerant discharge pressure.
 - (f) Motor current overload and phase loss.
 - (g) Low oil flow.
 - 3) Remote Alarm: Activate remote, audible bell upon safety shutdown of chiller.
 - e. Points for Remote Monitoring and Control:
 - 1) Minimum Data Transmission to BAS:
 - (a) All system operating conditions.
 - (b) Capacity control information.
 - (c) Safety shutdown conditions.
 - 2) Minimum Operating Commands from BAS:
 - (a) Remote unit start/stop.
 - (b) Remote chilled water reset.

H. Electrical:

1. Compliance: NEMA 250 or UL 1995 as applicable.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Connect to condenser water piping.
- G. Arrange piping for easy dismantling to permit tube cleaning and removal.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.
- B. Supply initial charge of refrigerant and oil if not completely factory charged.
- C. Demonstrate system operations and verify specified performance.

3.3 CLOSEOUT ACTIVITIES

- A. See Section 017700-Closeout Submittals for closeout submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.
- C. Demonstration: Demonstrate operation of system to Owner's personnel.
 1. Use operation and maintenance data as reference during demonstration.
 2. Briefly describe function, operation, and maintenance of each component.
- D. Training: Train Owner's personnel on operation and maintenance of system.
 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of two hours of training.

END OF SECTION 236423

SECTION 237223

PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Energy recovery units.
- B. Casing.
- C. Fans.
- D. Total energy wheel.
- E. Filters.
- F. Dampers.
- G. Vibration isolation.
- H. Roof curbs.
- I. Power and controls.
- J. Accessories.
- K. Service accessories.

1.2 RELATED REQUIREMENTS

- A. Section 238129 - Water Source Heat Pumps

1.3 REFERENCE STANDARDS

- A. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment.
- B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- C. ASHRAE Std 84 - Method of Testing Air to Air Heat/Energy Exchangers.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. NFPA 70 - National Electrical Code.
- G. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. See Section 013300 – Submittal Procedures, for submittal procedures.
- B. Product Data: Manufacturer's installation instruction, product data, and engineering calculations.
- C. Shop Drawings: Show design and assembly of energy recovery unit and installation and connection details.

1.5 WARRANTY

- A. Warranty energy recovery wheel to be free from defects in material and workmanship for 5 years under circumstances of normal use.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Energy Recovery Ventilators:
 - 1. Venmar.
 - 2. Innovent.
 - 3. Valent.
 - 4. Substitutions: See Section 016000 - Product Requirements.

2.2 ENERGY RECOVERY UNITS

- A. Energy Recovery Units: Provide desiccant wheel type or stationary core air-to-air exchanger; prefabricated packaged system designed by manufacturer.
 - 1. Provide unit with an AHRI 1060 (I-P) compliant air-to-air exchanger.
 - 2. Access: Hinged and/or screwed access panels on front.
 - 3. Framing: Welded extruded aluminum tubular frame capable of supporting components and casings.
- B. Accessories:
 - 1. Make-up Air Damper: Normally closed damper to replace exhausted air.
 - a. Duct Construction: Galvanized steel.
 - b. Provide with pressure switch and electric actuator.
 - c. Electrical Requirements:
 - 1) 24-volt transformer.
 - 2) Equipment wiring to comply with requirements of NFPA 70.

2.3 CASING

- A. Wall, Floor, and Roof Panels:
 - 1. Construction: 2 inch thick, double wall box construction, with formed edges of exterior wall overlapping formed edges of interior wall.
 - 2. Exterior Wall: Galvanized steel sheet.

- a. 20 gage, 0.0359 inch galvanized steel.
 3. Interior Wall: Galvanized sheet metal.
 - a. 22 gage, 0.0299 inch galvanized sheet metal.
 4. Insulation:
 - a. 2 inch foil-faced high density polystyrene foam.
 - b. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.
 - c. Smoke Developed Index (SDI): 50, maximum, when tested in accordance with ASTM E84 or UL 723.
 5. Panel Joints: T-shaped standing seams with overlapping metal caps.
 6. Isolation and Seal: Form continuous, thermally isolated, weather tight seal between inner wall of panels and structural framing with closed cell PVC foam gasketing.
 7. Seams: Sealed, requiring no caulking at job site.
- B. Access Panels: Provide access to components through a large, tightly sealed and easily removable panel.
- C. Doors:
1. Construct doors of same construction and thickness as wall panels.
 2. Height: 80 inches.
 3. Hardware:
 - a. Hinges: Aluminum.
 - b. Provide exterior handle and interior 3-point latching device.
- D. Install panels on structural framing with self-tapping stainless steel screws with integral neoprene-backed stainless steel washers.
- E. Weather Hood: Provide on fresh air inlet and exhaust air outlet; removable for access.
1. Construction: ASTM A653/A653M, G90/Z275 galvanized, 20 gauge, 0.0359 inch steel sheet.
 2. Screening: Expanded aluminum bird screen.
 3. Fresh Air Weather Hood: Maintain a face velocity less than 340 feet/min.

2.4 FANS

- A. Provide separate fans for exhaust and supply blowers.
- B. Fans:
1. Backward inclined.
 2. Class 1 aluminum wheels.
 3. AMCA-rated.
 4. Provide with non-overloading characteristics.
 5. Provide non-sparking integral spun steel venturie inlet cones.
- C. Bearings:
1. Pillow block.
 2. Bearings: Permanently lubricated sealed ball bearings.
 3. Rated for not less than 200,000 hours of operation with accessible greased fittings.

D. Housings: 12 gauge, 0.1046 inch aluminized steel with plenums integral to general housing and constructed to Class 1 fan standards.

E. Motors:

1. Motors: Open drip proof.
2. Efficiency: High.
3. Speed: Single.
4. Control: Variable Frequency Drive.
5. Fan Motor: UL listed and labeled.

F. Drives:

1. Fans: Belt driven.
2. Service Factor: 1.2.

2.5 TOTAL ENERGY WHEEL

A. Wheel: Transfer heat and humidity from one air stream to the other with minimum carryover of the exhaust air into the supply air stream.

B. Energy Wheel Media: Cleanable with low temperature steam, hot water or light detergent, without degrading the latent recovery.

C. Wheel Effectiveness: Rated in accordance with ASHRAE Std 84 and AHRI 1060 (I-P).

D. Flame Spread Index (FSI): 25 or less, when tested in accordance with ASTM E84 or UL 723.

E. Smoke Developed Index (SDI): 50 or less, when tested in accordance with ASTM E84 or UL 723.

F. Energy Recovery Wheel Media Face:

1. Comply with NFPA 90A.

G. Rotor:

1. Type: Non-segmented hygroscopic aluminum wheel.
2. Rotor Matrix: Corrosion resistant aluminum alloy composed of alternating corrugated and flat, continuously wound layers of uniform widths.

H. Desiccant:

1. Type: 3A.

I. Pneumatic Seals: Extruded adjustable brush seals.

1. Locations:
 - a. Around perimeter of wheel, and mounted perpendicular to face of wheel.
 - b. Separation between exhaust and supply air streams on both sides of wheel.

J. Drive:

1. Drive: Tensioned drive with full perimeter link style belt.

K. Wheel Rotation Detection:

1. Turn off energy recovery unit if improper rotor rotation is detected.

2. Send alarm to Building Management System if rotation is not detected or belt is slipping.

2.6 FILTERS

- A. Exhaust and Fresh Air Streams: 2" MERV 8 filters constructed to meet ASHRAE Std 52.2.
- B. Filter Racks: Bolt-on rack constructed of 0.08 inch, minimum, thick aluminum with hinged side access door and snap fasteners.
- C. Pre-Filter: 30-30 pleated filters, 2 inches thick on outside air inlet.
- D. Provide spare set of filters.

2.7 DAMPERS

- A. Motorized Dampers: Provide motorized dampers at outside air inlet, exhaust air outlet, and supply air outlet.
 1. Type: Motorized two position parallel blade damper with blade seals.
 2. Motorized Damper: Roll-formed structural hat channels, reinforced at the corners,
 3. Blades: Single skin, 16 gauge, 0.0598 inch.
 4. Blade Edge Seals: PVC coated polyester fabric suitable for minus 25 degrees F to 180 degrees F.
 5. Jamb Seals: Flexible stainless, compression type to prevent leakage between end of the blade and the damper frame.
 6. Conceal linkage out of air stream, within damper frame to reduce pressure drop and noise and lessen need for maintenance.

2.8 VIBRATION ISOLATION

- A. Vibration Isolation: Provide whole unit vibration isolation with the energy recovery unit assembly.
- B. Construct with appropriately-sized, seismic-rated, corrosion-resistant captive-spring isolators.

2.9 ROOF CURBS

- A. Curbs: Provide full perimeter roof curb fabricated from 10 gauge, 0.1345 inch aluminized steel.

2.10 POWER AND CONTROLS

- A. Motor Control Panels: UL listed.
- B. Include necessary motor starters, fuses, transformers and overload protection according to NFPA 70.
- C. Provide single-point field connection to power supply.
- D. Install wiring in accordance with NFPA 70.
- E. Wiring: Enclosed in flexible, liquid tight steel conduit.

2.11 ACCESSORIES

- A. Rotation Detector:

1. Equip unit with rotation sensor.
2. Equip controller with outdoor air temperature sensor that stops energy recovery wheel during moderate temperature periods.
3. Allow the energy recovery wheel to be operated in stop mode during very low temperature periods to prevent freezing of wheel while still delivering outdoor air through the unit.

B. Electric Preheat Coil:

1. Resistance coil type with elements enclosed in a steel sheath with fins and painted with a baked-on aluminum paint for long life in a 100 percent outdoor air stream.
2. Coil: UL listed and constructed in accordance with NFPA 70 requirements.

C. Freeze Protection Thermostat:

1. Equip unit with thermostat such that unit can be stopped when temperature drops to 23 degrees F.

2.12 SERVICE ACCESSORIES

A. Internal Service Lights: Provide vapor tight light with protective cage and minimum 40 watt bulb.

B. Electrical Receptacle:

1. Provide duplex, ground fault interrupter type receptacle.

C. Electrical Components: Factory wired for single point power connection.

1. Electrical Components: UL Listed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that structure is ready for installation of unit, that openings in deck for ductwork, if required, are correctly sized and located, and that mechanical and electrical utilities supplying unit are of correct capacities and are accessible.

3.2 INSTALLATION

A. Provide openings for suitable ductwork connection.

3.3 SYSTEM STARTUP

A. Provide services of manufacturer's authorized representative to provide startup of unit.

3.4 CLEANING

A. Clean filters, air plenums, interior and exposed-to-view surfaces prior to Substantial Completion.

END OF SECTION 237223

SECTION 238200

CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fan-coil units.
- B. Blower-coil units.
- C. Thermostatic controls.

1.2 RELATED REQUIREMENTS

1.3 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
- B. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
- C. AHRI 440 - Performance Rating of Room Fan-Coil Units.
- D. NFPA 70 - National Electrical Code.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.4 SUBMITTALS

- A. See Front End Specifications for Administrative Requirements for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Selection Samples: For each finish product specified, color chart representing manufacturer's full range of available colors.
- D. Verification Samples: For each finish product specified, color chip representing actual product in color and texture.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 WARRANTY

- A. See Section 017700-Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.1 FAN-COIL UNITS

A. Manufacturers:

1. Vertical Cabinet, Horizontal Exposed, or Horizontal Recessed:
 - a. Carrier Corporation.
 - b. Daikin Applied.
 - c. Jaga.
 - d. Krueger-HVAC.
 - e. Trane Technologies.

B. Performance Data and Safety Requirements:

1. Unit capacities certified in accordance with AHRI 440.
2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
3. Insulation to comply with NFPA 90A requirements for flame spread and smoke generation.
4. Equipment wiring to comply with requirements of NFPA 70.

C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

D. Coils:

1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
2. Water Coil: Suitable for working temperatures not less than 200 degrees F.
3. Provide drain pan under cooling coil easily removable for cleaning.

E. Coil Piping Packages:

1. Manufacturers:
 - a. Griswold Controls.
 - b. Hays Fluid Controls.
 - c. IMI Flow Design, a brand of IMI Hydronic Engineering Division of IMI PLC
: www.flowdesign.com/#sle.
2. Hoses:
 - a. Provide hoses for all units for connection to main water supply and return headers.
 - b. Length: 2 feet.
 - c. Material: Braided stainless steel rated to minimum 400 psi at 265 degrees F.
3. Automatic Balancing Valves:
 - a. Brass body for shutoff and hydronic balancing.
4. Ball Valves:
 - a. Brass body for shutoff and hydronic balancing.
 - b. Provide pressure/temperature ports.
5. Y Strainers:
 - a. Bronze body.
 - b. "Y" type configuration with brass cap.
 - c. Maximum Operating Pressure: Minimum 450 psi.
 - d. Screen: Stainless steel.

- F. Vertical Cabinet and Horizontal Exposed Units: Minimum 18 gauge, 0.0478 inch thick sheet steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.
- G. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- H. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- I. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- J. Controls:
 - 1. Provide units with control valves furnished by the fan coil unit manufacturer.
 - 2. Fan Coil Unit Manufacturer's Controls:
 - a. Disconnect switch.
 - b. Programmable thermostat.
 - 3. Controls Interface:
 - a. Relay board.
 - b. 24-volt transformer.
- K. Filter: Easily removed 1 inch thick glass fiber throw-away type, located to filter air before coil.
- L. Fresh Air Dampers: Where indicated, manual type, set to allow maximum of 25 percent fresh air to enter space.
- M. Electrical Characteristics:

2.2 BLOWER-COIL UNITS

- A. Performance Data and Safety Requirements:
 - 1. Coils rated and tested in accordance with AHRI 410.
 - 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
 - 3. Comply with NFPA 90A for unit construction, including filters and related equipment, for protection of life and property from fire, smoke, and gases resulting from conditions having manifestations similar to fire.
- B. Unit Casing:
 - 1. Fabricate from heavy gauge galvanized steel sheet.
 - 2. Insulate inside walls with 1 inch thick, fiberglass insulation for thermal and acoustical control.
 - 3. Provide access panels allowing servicing of coils, drain pan, fan, motor, and drive.
 - 4. Provide knockouts or hanger rod holes at all four corners for suspended units.
- C. Air Coils:
 - 1. Aluminum fins mechanically expanded or bonded to copper tubes having standard sweat connections.

- a. Water: Manual, automatic or self-venting, designed to a working pressure and temperature of not less than 250 psig and 200 degrees F.
- D. Fans: Forward curved, centrifugal blower, dynamically balanced, adjustable speed V-belt drive with fan shaft supported by heavy-duty, permanently sealed ball bearings.
- E. Drain Pan: Cleanable, one-piece construction of polymer, galvanized steel, or stainless steel; with drain connection and sloped for positive drainage.
- F. Filters: Fully accessible, flat filter rack with throw-away filters.
- G. Motors: Single speed with sleeve or ball bearings, 1,750 rpm, wired to unit junction box, and mounted on a resilient motor base.
- H. Electrical Controls:
 - 1. 24-volt control circuit transformer.
 - 2. Motor circuit fusing.
 - 3. Fan contactor.
 - 4. Terminal strip for connection of field wiring.
 - 5. Disconnecting means for main incoming power.

2.3 THERMOSTATIC CONTROLS

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Do not damage equipment or finishes.
- D. Fan-Coil Units:
 - 1. Install as indicated.
 - 2. Coordinate to ensure correct recess size for recessed units.
- E. Units with Cooling Coils: Connect drain pan to condensate drain.
- F. Blower-Coil Units:
 - 1. Verify all surfaces and openings at unit location can suitably accommodate unit(s).
 - 2. Install in accordance with manufacturer's recommendations.
 - 3. Provide manual shut-off valve on hydronic supply side of coil and balancing valve with memory stop on return side.
 - 4. General piping installation requirements are specified in other Sections and drawings indicate general arrangement of piping, fittings, and specialties.

3.2 CLEANING

- A. After construction and painting is completed, clean exposed surfaces of units.

- B. Vacuum clean coils and inside of units.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
- D. Install new filters.

3.3 CLOSEOUT ACTIVITIES

- A. See Section 017700-Closeout Submittals for closeout submittals.
- B. See Section 017900 - Demonstration and Training for additional requirements.

END OF SECTION 238200

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SECTION 260101

COMMON ELECTRICAL WORK

PART 1 GENERAL

1.1 SCOPE

- A. This Section shall apply to all Contractors and Subcontractors that are responsible for Division 26, and 28.
- B. The work covered by this Section of the Specifications consists of furnishing all labor and materials (unless otherwise specified) and in performing all operations necessary for the installation of the complete electronic and electrical system as required by terms and conditions of the Contract. The work shall also include the completion of such details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical and electronic systems described on the drawings or required by these Specifications.
- C. The work in this Contract involves the installation of new work as well as work on the Site and may include demolition and renovation work. It shall be this Contractor's responsibility to visit the site so that he may ascertain all existing conditions which may affect the work under his Contract. No additional compensation will be granted for additional work required by this Contractor for his failure to visit the jobsite and determine existing conditions. This Contractor shall provide all labor and materials required to complete the work described in the Plans and Specifications and as may be required for a ready to operate installation.
- D. Generally the removal and repairing of existing floors, walls, ceilings, etc., in the remodeled areas where required for the installation of conduit, lights, panels, etc., shall be provided by the General Contractor under the direction of this Contractor. Holes required through floors, walls, and roof of the building shall be provided by this Contractor. If specifically shown to be done by this Contractor, this Contractor shall include in his Contract price the removal and replacement of general construction materials as required.

1.2 DEFINITIONS

- A. Where the terms "provide" or "shall be" are used in the Specifications or Plans, they shall be taken to mean, "the Electrical Contractor shall furnish and install".
- B. Where the word "electrical" is used in these Specifications and Plans it shall mean both "electrical and electronic" as the case may be.
- C. The term "Contractor" used throughout Division 26, and 28 of these Specifications shall be understood to mean the Electrical Contractor.
- D. The term "as shown on the drawings" has been omitted from this Specification, but it shall be understood that the drawings and Specifications complement one another and items specified shall also meet the criteria set forth on the drawings.

1.3 DRAWINGS

- A. The drawings which constitute a part of this Contract indicate the general arrangement of circuits and outlets, locations of switches, panelboards, and other work. The Drawings and Specifications are complimentary each to the other, and what is called for by one shall be binding as if called for by both. Data presented on these drawings are as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all Architectural, Structural, and Mechanical Plans and adjust all work to conform to all conditions shown therein. The Architectural Drawings shall take precedence over all other drawings as to dimensions.

1.4 CONFLICTS

- A. Any conflict noted between (1) the Drawings; (2) Specifications; or (3) Drawings and Specifications; or (4) between Plans and Codes or Ordinances or (5) between the Plans or Specifications and Manufacturer's installation recommendations shall be immediately brought to the attention of the Architect for clarification. If conflicts are discovered prior to bidding and there is not sufficient time to obtain a clarification from the Architect prior to bidding, the Contractor shall bid the larger quantity or better quality of work. All conflicts shall be brought to the attention of the Architect when discovered and before installation.
- B. Contractor shall be responsible to field measure and confirm mounting heights and locations of electrical equipment with respect to counters, radiation, etc. Do not scale distances off the Electrical Plans. Use actual building dimensions from the Architectural Drawings.

1.5 WORK IN EXISTING BUILDINGS

- A. All work in existing buildings, indicated on the drawings or specified herein, shall be executed with a minimum amount of interference with the normal activities of the occupants of the building. No services or utilities shall be interrupted without previous scheduling time of the same with the Owner and receipt of his approval. Changing of the electrical system, telephone system, and other major events shall be arranged and be agreeable with the Owner to length and time of downtime. All work shall be scheduled in advance with the Owner and shall not proceed without the Owner's written approval.
- B. The Owner shall be notified before starting to weld or cut. Fire extinguishers shall be immediately accessible when welding or cutting with an open flame or arc. Welding or cutting with an open flame or arc must be stopped in a timely fashion before leaving premises.
- C. Noisy operations such as those involving use of air hammers, etc., in demolition, or cutting of openings shall be scheduled with the Owner.
- D. Typically, the Owner will continue to occupy the building and carry on normal activity. Each Contractor shall protect the occupied areas from dust, smoke, etc., by a method approved by the Owner/Architect.

1.6 EXAMINATION OF SITE

- A. Prior to submitting a bid, this Contractor shall visit the site of the job and ascertain all conditions affecting the proposed electrical installation and make provisions as to the cost thereof. No additional compensation will be granted for additional work required by this Contractor for failure to visit jobsite and determine existing conditions. The Contractor shall verify location and size of existing systems that are to be connected to, routed around, or extended from.

- B. The Contractor shall verify with the City and Utility Companies, and Owner, etc., the location of any existing overhead or buried utilities on or near the site. The Contractor shall verify requirements for connecting into existing utilities with the City and Utility Company, and Owner and connect into as required. Failure to determine existing conditions or the nature of new connections will not be considered a basis for the granting of additional compensation.

1.7 PRIOR APPROVAL

- A. The Contractors attention is directed to the requirement of "prior approval" for materials to be supplied in this project if they are not specifically designated as a specified manufacturer or approved equal.
- B. Prior approval requires that literature be submitted to the Architect a minimum of ten (10) days prior to the bidding date. This submitted material shall be informative enough to allow the Engineer to give approval. This approval is a tentative approval and does not imply anything but approval to bid.

1.8 SHOP DRAWINGS

- A. The Contractor shall submit Shop Drawings of all items of equipment listed in this Specification and on the Drawings. Shop Drawings shall also include light fixtures, wiring devices, disconnect switches, panels, etc. provided under this Contract. Shop Drawings shall be submitted whether they are the exact specified manufacturer's numbers or a different manufacturer and number.
- B. Where an item or portion of the equipment differs from the Specifications, this fact shall be called to the attention of the Engineer to permit evaluation of the alternate item. Approval of the equipment will be only to the degree that the information is shown on the submittal and it shall not be construed to mean approval of items, materials, or details not shown but which are required by the Specification or Plans.
- C. Shop Drawings will be reviewed to the extent of the information shown on the submittal. Review of an item of equipment cannot be construed to mean approval for components of that item of equipment for which no information is furnished to show compliance with Plans and Specifications. Where additional work, controls, wiring, components, etc., are required to install and or make an operable system, or such controls, wiring components etc., are required by the Plans and Specifications, the approval of these drawings shall not relieve the Contractor from furnishing all items and the quantity required.
- D. Shop Drawings shall indicate manufacturer's delivery time for the item after receipt of approval by the Engineer.

1.9 USE OF OTHER THAN SPECIFIED EQUIPMENT

- A. All equipment installed on the project shall be the specified equipment shown on the drawings. If the Contractor uses different approved equipment than what was specified, all additional work or components required to make an operable system shall be made without additional cost to the Owner. The Contractor shall be held responsible for selecting different approved equipment so that equipment will fit into the available space provided for the specified equipment.

1.10 PERMITS AND LICENSES

- A. Obtain and pay all permits and licenses required and furnish the Architect for the Owner a certificate of final inspection and approval from the Local Authority having jurisdiction over this electrical installation.

1.11 WARRANTY

- A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, without additional charge, any work or material (except materials not furnished by the Electrical Contractor) which develops defects from ordinary wear and tear within one (1) year from the date of acceptance, or provide extended warranty, as specified. All new material and equipment shall be warranted against defects in composition, design, or workmanship. Lamps shall be warranted for their published life. Warranty certificates shall be furnished on special equipment.

1.12 PROGRESS OF WORK AND DOWNTIME

- A. Order the progress of the electrical work so as to conform to the progress of the work as scheduled in the Specifications and complete the entire installation as soon as the condition of the building will permit. Any cost resulting from defective or ill-timed work performed under this Section shall be borne by this Contractor.
- B. As much of this building may be occupied when construction is ongoing it will be of prime importance to coordinate downtime of electrical systems with the Owner. Changing of the electrical entrance and other major events shall be arranged and be agreeable with the Owner to length and time of downtime.

1.13 COORDINATION

- A. The Contractor shall confirm dimensions noted and locations of General and Mechanical Contractor's equipment as well as equipment to be furnished by the Owner. Verify all equipment and motor sizes, voltage and connection requirements for equipment furnished by others and wired under this Contract before roughing-in, and provide proper branch circuits and connections as recommended by equipment manufacturers. Coordinate with the other contractors to avoid interference with ductwork, structural members, grilles, cabinetwork, etc. Motors shall not be connected to until verification has been made that motor running protection exists.
- B. Where the drawings indicate fixtures and equipment which are to be furnished by others (or Owner) and which require connections to the electrical systems, the Electrical Contractor shall furnish and install all rough-in of conduit, boxes, conductors, disconnect switches, plugs with pigtails, receptacles etc., which are required for the final connections. Rough-in locations and required connections shall be determined from the equipment itself or from the equipment manufacturer's shop drawings. Final connections to the equipment shall be made by this Contractor.

1.14 CUTTING AND PATCHING

- A. Each Contractor shall be responsible for all cutting and patching required for his work. Carefully lay out all work in advance and where cutting, channeling, chasing, or drilling of building surfaces is necessary for the proper installation of electrical equipment, carefully perform this work in a manner approved by the Architect. Patching shall be done in a neat workmanlike manner by craftsmen skilled in the trade involved and shall be prepared to receive paint. Damaged surfaces shall be repaired at no cost to the Owner. Concrete walls shall be cut only with rotary type drilling tools. Openings through floors and walls may be drilled up to 1" but shall be cored over 1". Electrical equipment shall not be cut with torches, and shall be joined only by bolting (i.e., do not weld wireways to panels, etc.).

1.15 INDUSTRY STANDARDS AND CODES

- A. The complete installation shall comply with the applicable Local and State wiring ordinances, with the regulations of the latest edition of the National Electrical Code of the National Fire Protection Association (supplements and official interpretations included) and with the requirements of the Power, Television, and Telephone Companies furnishing service to this installation. The drawings and specifications take precedence when they are more stringent than codes, ordinances, or statutes in effect, and vice versa. In addition, the following latest industry standards, specifications, and codes are minimum requirements.
1. The National Electrical Manufacturer's Association Standards
 2. The National Electrical Safety Code
 3. Underwriter's Laboratories, Inc., Standards
 4. International Building Code
 5. International Fire Code
 6. International Energy Conservation Code
 7. State Health Department
 8. State Building Codes
 9. State Fire Codes
 10. State Energy Codes
- B. All work shall be in accordance with State and Local Codes and requirements of Local Utilities. Where the applicable Building Codes and the drawings or specifications do not agree, the code shall take precedence, but only in cases where what is shown on the drawings or required by the specifications violates the code. Where there is a Code or Utility Company requirement and drawing or specification discrepancy the Code shall have precedence only when it is more stringent than the item specified or shown on the drawings. Items that are allowable by the Local Building Codes, which are less stringent than that required by the specifications or the drawings the less stringent work, shall not be substituted.

1.16 RESPONSIBILITY OF THE CONTRACTOR

- A. The Contractor and his journeymen shall have Electrical Licenses, as required by the City and State in which work is being performed, and shall provide journeymen to work as superintendents and/or foremen on the project. All workmen shall be skilled in their trade or working under someone who is skilled in the trade and responsible for the work involved.
- B. The Contractor shall be totally responsible for his portion of the work from the date of his Contract until final acceptance of the building by the Owner, and must repair all damage sustained without cost to the Owner regardless of cause. The Contractor shall use proper care and diligence in bracing and securing all parts of the work against the elements and shall, in all cases, judge as to the amount of protection required. Proper storage of material shall be maintained at all times.

1.17 TEMPORARY POWER AND LIGHTING

- A. The Electrical Contractor shall provide electrical wiring and light fixtures for temporary power, heating, and lighting in construction areas.

1.18 FIRE AND SMOKE STOPPAGE

- A. It shall be the responsibility of this Contractor to maintain the fire and smoke integrity of all walls, ceilings, floors etc., through which his work passes through or into. Fire and smoke barriers shall be provided in and around as required by Codes.

- B. Where holes are required to be patched, or conduit, piping, ducts, etc., are required to be patched around, it shall be filled with a material that is UL Classified Standard 1479 for this use and Factory Mutual System approved.

1.19 ACCESS TO EQUIPMENT

- A. All control devices, specialties, pull boxes, disconnect switches, and similar equipment shall be so located as to provide for easy access for operation, repair and maintenance. Access shall conform to Local Electric Codes. Access doors shall be provided if devices are concealed.

1.20 TESTS

- A. At the completion of his work, the Contractor shall perform the following tests in the presence of the Architect.
 - 1. Test for short circuits and grounds.
 - 2. Test to prove correct operation of all equipment, including lighting control systems.
 - 3. Check for balance of load on phases, and connect load to balance as closely as possible. Should the Power Company disclose any unfavorable conditions or reactions on the service, the Contractor shall make changes as may be suggested to properly balance the load.

1.21 CLEAN-UP

- A. The Contractor shall remove all rubbish and debris resulting from his work daily and shall leave equipment that he installed clean and ready for operation.

1.22 RECORD DRAWINGS

- A. Maintain a clean, undamaged set of whiteprints of Contract Drawings. Mark the set to show the actual installation where the installation varies from the work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
 - 1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the work.
 - 2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
 - 3. Note related Change Order numbers where applicable.
 - 4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dated and other identification on the cover of each set.
 - 5. Turn Record Drawings over to the Owner with the Operation and Maintenance Manuals.

END OF SECTION 260101

SECTION 260505
DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Demolition drawings are based on casual field observation and existing record documents.
- C. Report discrepancies to Engineer before disturbing existing installation.
- D. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- 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.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.
- E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Notify local fire service.
 - 2. Make notifications at least 24 hours in advance.

3. Make temporary connections to maintain service in areas adjacent to work area.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 2. PCB- and DEHP-containing lighting ballasts.
 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- 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.
- I. Repair adjacent construction and finishes damaged during demolition and extension work.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

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

END OF SECTION 260505

SECTION 260519

CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Oxide inhibiting compound.
- E. Wire pulling lubricant.
- F. Cable ties.
- G. Firestop sleeves.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260505 - Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 260526 - Grounding and Bonding: Additional requirements for grounding conductors and grounding connectors.
- D. Section 260536 - Cable Trays: Additional installation requirements for cables installed in cable tray systems.
- E. Section 260553 - Identification: Identification products and requirements.
- F. Section 260923 - Lighting Controls
- G. Section 262100 - Electrical Service Entrance: Additional requirements for electrical service conductors.
- H. Section 284600 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation.
- E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers.
- F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation.
- G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.
- H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes.
- I. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); Federal Specification.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- K. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable.
- L. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
- M. NFPA 70 - National Electrical Code.
- N. UL 44 - Thermoset-Insulated Wires and Cables.
- O. UL 83 - Thermoplastic-Insulated Wires and Cables.
- P. UL 486A-486B - Wire Connectors.
- Q. UL 486C - Splicing Wire Connectors.
- R. UL 486D - Sealed Wire Connector Systems.
- S. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Engineer and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
- G. Metal-clad cable is not permitted.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- H. Conductors for Grounding and Bonding: Also comply with Section 260526.
- I. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- J. Conductor Material:
 - 1. Provide copper conductors except where indicated below. Conductor sizes indicated are based on copper.
 - a. Substitution of aluminum conductors for copper is permitted, when approved by Owner and authority having jurisdiction, only for the following:
 - 1) Services: Copper conductors size 1/0 AWG and larger.
 - 2) Feeders: Copper conductors size 1/0 AWG and larger.
 - b. Where aluminum conductors are substituted for copper, comply with the following:
 - 1) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
 - 2) Increase size of raceways, boxes, wiring gutters, enclosures, etc. as required to accommodate aluminum conductors.
 - 3) Provide aluminum equipment grounding conductor sized according to NFPA 70.
 - 4) Equip electrical distribution equipment with compression lugs for terminating aluminum conductors.
 - c. Connections to vibrating equipment, motors, and mechanical equipment shall be made with copper conductors only.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
 - 4. Aluminum Conductors (only where specifically indicated or permitted for substitution): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.

- K. Minimum Conductor Size:
1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 2. Control Circuits: 14 AWG.
- L. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- M. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.
 - d. Travelers for 3-Way and 4-Way Switching: Purple.
 - e. For control circuits, comply with manufacturer's recommended color code.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - d. Southwire Company: www.southwire.com/#sle.
 2. Aluminum Building Wire (only where specifically indicated or permitted for substitution):
 - a. Encore Wire Corporation: www.encorewire.com/#sle.
 - b. Southwire Company: www.southwire.com/#sle.
 - c. Stabiloy, a brand of General Cable Technologies Corporation: www.stabiloy.com/#sle.
- B. Description: Single conductor insulated wire.

- C. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
 - a. Size 4 AWG and Larger: Type XHHW-2.
 - b. Installed Underground: Type XHHW-2.
 - c. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.
 - 2. Aluminum Building Wire (only where specifically indicated or permitted for substitution): Type XHHW-2.

2.4 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 260526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
 - 5. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. IlSCO: www.ilsco.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.

2.5 ACCESSORIES

- A. Electrical Tape:
1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
 2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 4. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
- B. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.

- C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. American Polywater Corporation: www.polywater.com/#sle.
 - c. Ideal Industries, Inc: www.idealindustries.com/#sle.
- D. Cable Ties: Material and tensile strength rating suitable for application.
- E. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.3 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 5. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.

7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install aluminum conductors in accordance with NECA 104.
- E. Installation in Raceway:
 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Exposed Cable Installation (only where specifically permitted):
 1. Route cables parallel or perpendicular to building structural members and surfaces.
 2. Protect cables from physical damage.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
- I. Install conductors with a minimum of 12 inches of slack at each outlet.
- J. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- M. Make wiring connections using specified wiring connectors.
 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.

2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.
 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 5. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
 6. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 7. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
- O. Insulate ends of spare conductors using vinyl insulating electrical tape.
- P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- Q. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.
- R. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 260519

SECTION 260526

GROUNDING AND BONDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 260536 - Cable Trays: Additional grounding and bonding requirements for cable tray systems.
- C. Section 260553 - Identification: Identification products and requirements.
- D. Section 265600 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.3 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
- D. NFPA 70 - National Electrical Code.
- E. UL 467 - Grounding and Bonding Equipment.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

- A. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Engineer. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 2. Grounding Electrode System: Not greater than 25 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
- F. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 2. Metal Underground Water Pipe(s):

- a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
- b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
- c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
5. Ground Rod Electrode(s):
 - a. Provide two electrodes unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
7. Ground Bar: Provide ground bar, separate from service equipment enclosure unless noted otherwise, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 4 by 12 inches unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
- G. Service-Supplied System Grounding:
 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
 3. All metallic meter enclosures, CT Cabinets, and metallic conduit shall be bonded to the system per the NEC, see Article 250.9.
- H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 1. Provide grounding electrode system for each separate building or structure.
 2. Provide equipment grounding conductor routed with supply conductors.

3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.

I. Separately Derived System Grounding:

1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

J. Bonding and Equipment Grounding:

1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, CT cabinets, meter sockets, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.

8. Provide an insulated bonding conductor in each conduit from main switch to Service Entrance equipment such as CT Cabinets and Meter Sockets located remotely from the main switch per NEC 250.92.

K. Cable Tray Systems: Also comply with Section 260536.

L. Pole-Mounted Luminaires: Also comply with Section 265600.

2.2 GROUNDING AND BONDING COMPONENTS

A. General Requirements:

1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:

1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
4. Manufacturers - Mechanical and Compression Connectors:
 - a. Advanced Lightning Technology (ALT): www.altfab.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. Thomas & Betts Corporation: www.tnb.com/#sle.
5. Manufacturers - Exothermic Welded Connections:
 - a. Cadweld, a brand of Erico International Corporation: www.erico.com/#sle.
 - b. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

D. Ground Bars:

1. Description: Copper rectangular ground bars with mounting brackets and insulators.
2. Size: As indicated.
3. Holes for Connections: As indicated or as required for connections to be made.
4. Manufacturers:
 - a. Erico International Corporation: www.erico.com/#sle.
 - b. Harger Lightning & Grounding: www.harger.com/#sle.
 - c. thermOweld, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com/#sle.

E. Ground Rod Electrodes:

1. Comply with NEMA GR 1.
2. Material: Copper-bonded (copper-clad) steel.
3. Size: 5/8 inch diameter by 10 feet length, unless otherwise indicated.
4. Manufacturers:
 - a. Erico International Corporation: www.erico.com/#sle.
 - b. Galvan Industries, Inc: www.galvanelectrical.com/#sle.
 - c. Harger Lightning & Grounding: www.harger.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.
 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 260553.

END OF SECTION 260526

SECTION 260529

HANGERS AND SUPPORTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260533 - Conduit: Additional support and attachment requirements for conduits.
- C. Section 260536 - Cable Trays: Additional support and attachment requirements for cable tray.
- D. Section 260535 - Boxes: Additional support and attachment requirements for boxes.
- E. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
- F. Section 265600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- D. MFMA-4 - Metal Framing Standards Publication.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- F. NFPA 70 - National Electrical Code.
- G. UL 5B - Strut-Type Channel Raceways and Fittings.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 033000.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.25. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or stainless steel unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

- d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
 - 3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
 - 1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Erico International Corporation: www.erico.com/#sle.
 - c. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Comply with MFMA-4.
 - 2. Channel Material:
 - a. Indoor Dry Locations: Use galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 3. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Single Conduit up to 1 inch (27 mm) trade size: 1/4 inch diameter.
 - c. Single Conduit larger than 1 inch (27 mm) trade size: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
 - e. Outlet Boxes: 1/4 inch diameter.
 - f. Luminaires: 1/4 inch diameter.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
4. Hollow Masonry: Use toggle bolts.
5. Hollow Stud Walls: Use toggle bolts.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Wood: Use wood screws.
9. Plastic and lead anchors are not permitted.
10. Powder-actuated fasteners are not permitted.
11. Hammer-driven anchors and fasteners are not permitted.
12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
13. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.
14. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. Powers Fasteners, Inc: www.powers.com/#sle.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Equipment Support and Attachment:

1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

I. Conduit Support and Attachment: Also comply with Section 260533.

J. Cable Tray Support and Attachment: Also comply with Section 260536.

K. Box Support and Attachment: Also comply with Section 260535.

L. Interior Luminaire Support and Attachment: Also comply with Section 265100.

M. Exterior Luminaire Support and Attachment: Also comply with Section 265600.

N. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

O. Secure fasteners according to manufacturer's recommended torque settings.

P. Remove temporary supports.

Q. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.3 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

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SECTION 260533

CONDUIT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Galvanized steel intermediate metal conduit (IMC).
- C. PVC-coated galvanized steel rigid metal conduit (RMC).
- D. Flexible metal conduit (FMC).
- E. Liquid-tight flexible metal conduit (LFMC).
- F. Galvanized steel electrical metallic tubing (EMT).
- G. Rigid polyvinyl chloride (PVC) conduit.
- H. Reinforced thermosetting resin conduit (RTRC).
- I. High-density polyethylene (HDPE) conduit.

1.2 RELATED REQUIREMENTS

- A. Section 078400 - Firestopping.
- B. Section 260526 - Grounding and Bonding.
 - 1. Includes additional requirements for fittings for grounding and bonding.
- C. Section 260529 - Hangers and Supports.
- D. Section 260535 - Boxes.
- E. Section 260534 - Surface Raceways.
- F. Section 260553 - Identification: Identification products and requirements.
- G. Section 262100 - Electrical Service Entrance: Additional requirements for electrical service conduits.
- H. Section 270533.13 - Conduit for Communications Systems.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).

- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit.
- D. ASTM F2160 - Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
- E. ASTM F2176 - Standard Specification for Mechanical Couplings Used on Polyethylene Conduit, Duct and Innerduct.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- G. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
- H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
- I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- J. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit.
- K. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
- L. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
- M. NEMA TC 7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
- N. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series.
- O. NEMA TC 14.BG - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
- P. NFPA 70 - National Electrical Code.
- Q. UL 1 - Flexible Metal Conduit.
- R. UL 6 - Electrical Rigid Metal Conduit-Steel.
- S. UL 360 - Liquid-Tight Flexible Metal Conduit.
- T. UL 514A - Metallic Outlet Boxes.
- U. UL 514B - Conduit, Tubing, and Cable Fittings.
- V. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- W. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
- X. UL 746C - Polymeric Materials – Use in Electrical Equipment Evaluations.
- Y. UL 797 - Electrical Metallic Tubing-Steel.
- Z. UL 1242 - Electrical Intermediate Metal Conduit-Steel.
- AA. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds.

BB. UL 2420 - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.
5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.5 SUBMITTALS

- A. See Section 013300 – Submittal Procedures for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

- A. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:

1. Under Slab on Grade: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit below grade prior to emerging from underground.
4. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows, PVC-coated galvanized steel rigid metal conduit elbows, or Reinforced thermosetting resin conduit (RTRC) for bends.
5. Where galvanized rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT) emerges from concrete into soil, use corrosion protection tape, factory-applied corrosion protection coating, or field-applied corrosion protection compound acceptable to authorities having jurisdiction to provide supplementary corrosion protection for minimum of 4 inches on either side of where conduit emerges.

D. Embedded Within Concrete:

1. Within Slab on Grade: Not permitted.
2. Within Slab Above Ground: Not permitted.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

F. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).

J. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

K. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.

1. Maximum Length: 6 feet.

L. Flexible Connections to Vibrating Equipment:

1. Dry Locations: Use flexible metal conduit (FMC).
2. Damp, Wet, or Corrosive Locations: Use liquid-tight flexible metal conduit.

3. Maximum Length: 6 feet unless otherwise indicated.
4. Vibrating equipment includes, but is not limited to:
 - a. Motors.

M. Fished in Existing Walls, Where Necessary: Use flexible metal conduit or hospital grade MC cable if permitted by local authorities.

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Electrical Service Conduits: See Section 262100 for additional requirements.
- C. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.
- D. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- E. Provide products listed, classified, and labeled as suitable for purpose intended.
- F. Minimum Conduit Size, Unless Otherwise Indicated:
 1. Branch Circuits: 3/4-inch trade size.
 2. Branch Circuit Homeruns: 3/4-inch trade size.
 3. Flexible Connections to Luminaires: 3/8-inch trade size.
 4. Underground, Interior: 3/4-inch trade size.
 5. Underground, Exterior: 1-inch trade size.
- G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 2. Material: Use steel.
 - a. Do not use die cast zinc fittings.
 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
 2. Material: Use steel.

- a. Do not use die cast zinc fittings.
- 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.5 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.
- C. PVC-Coated Boxes and Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
 - 3. Material: Use steel.
 - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
- D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.6 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel.
 - a. Do not use die cast zinc fittings.

2.7 LIQUID-TIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel.
 - a. Do not use die cast zinc fittings.

2.8 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
 - 1. Provided factory painted conduit as indicated in 26 05 53 Identification for Electrical Systems

B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
2. Material: Use steel.
 - a. Do not use die cast zinc fittings.
3. Connectors and Couplings: Use compression/gland or set-screw type.
 - a. Do not use indenter type connectors and couplings.
4. Damp or Wet Locations, Where Permitted: Use fittings listed for use in wet locations.

2.9 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

B. Fittings:

1. Manufacturer: Same as manufacturer of conduit to be connected.
2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.10 REINFORCED THERMOSETTING RESIN CONDUIT (RTRC)

A. Applications:

1. Underground, Direct-Buried: Use belowground (BG), DB (direct burial) RTRC.

- B. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).

1. Belowground (BG) RTRC: Comply with NEMA TC 14.BG and list and label as complying with UL 2420.

- C. Supports: As recommended by manufacturer.

- D. Fittings: Same type and manufacturer as conduit to be connected.

1. Cement-Tight Joints: Use bonded coupling or bell and spigot.
2. Cement-Tight and Watertight Joints: Use adhesive and manufacturer's standard gaskets.

2.11 HIGH-DENSITY POLYETHYLENE (HDPE) CONDUIT

- A. Description: NFPA 70, Type HDPE high-density polyethylene solid-wall conduit complying with ASTM F2160 and NEMA TC 7; list and label as complying with UL 651A; Schedule 40 unless otherwise indicated.

- B. Joining Methods: Approved by HDPE conduit manufacturer.

- C. Mechanical Fittings: Comply with ASTM F2176; list and label as complying with UL 651A.

2.12 ACCESSORIES

- A. Corrosion Protection Tape: PVC-based, minimum thickness of 20 mil, 0.020 inch.
- B. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.
- C. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- D. Epoxy Adhesive for RTRC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- E. Adhesive for HDPE and RTRC Conduit:
 - 1. Specifically designed for bonding dissimilar materials in lieu of transition fittings, including but not limited to polyethylene, fiberglass, PVC, aluminum, and steel; UL 746C recognized.
 - 2. Approved by adhesive manufacturer for use with materials to be joined.
- F. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbs.
- G. Sealing Systems for Concrete Penetrations:
 - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
- H. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- I. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by manufacturer.
- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Unless otherwise approved, do not route exposed conduits:
 - a. Across floors.
 - b. Across roofs.
 - c. Across top of parapet walls.
 - d. Across building exterior surfaces.
 - 6. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
 - 7. Arrange conduit to maintain adequate headroom, clearances, and access.
 - 8. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
 - 9. Arrange conduit to provide no more than 150 feet between pull points.
 - 10. Route conduits above water and drain piping where possible.
 - 11. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 - 12. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 - 13. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 - 14. Group parallel conduits in same area on common rack.
- H. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 - 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 - 4. Use conduit strap to support single surface-mounted conduit.

- a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use of spring steel conduit clips for support of conduits is permitted only as follows:
 - a. Support of electrical metallic tubing (EMT) up to 1-inch (27 mm) trade size concealed above accessible ceilings and within hollow stud walls.
 - b. Spring clips shall not be used to support conduits to ceiling support wires..
 9. Use of wire for support of conduits is not permitted.
 10. Where conduit support intervals specified in NFPA 70 and NECA standards differ, comply with most stringent requirements.
- I. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquid-tight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 7. Secure joints and connections to provide mechanical strength and electrical continuity.
- J. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Provide suitable sealing system where conduits penetrate exterior wall below grade.
 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 8. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 078400.

- K. Underground Installation:
 - 1. Provide trenching and backfilling.
 - 2. Minimum Cover, Unless Otherwise Indicated or Required:
 - a. Underground, Exterior: 18 inches.
- L. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
 - 1. Secure conduits to prevent floating or movement during pouring of concrete.
- M. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 - 3. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
 - 4. Where conduits are subject to earth movement by settlement or frost.
- N. Conduit Sealing:
 - 1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- O. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- P. Provide grounding and bonding; see Section 260526.
- Q. Install no more than equivalent of four 90 degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one shot bender to fabricate bends in metal conduit larger than 1 1/4 inch size.
- R. Identify conduits; see Section 260553.

3.3 FIELD QUALITY CONTROL

- A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- B. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- C. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

- A. Clean interior of conduits to remove moisture and foreign matter.

3.5 PROTECTION

- A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION 260533

SECTION 260534
SURFACE RACEWAYS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Surface raceway systems.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260529 - Hangers and Supports.
- C. Section 260533 - Conduit.
- D. Section 260535 - Boxes.
- E. Section 260553 - Identification: Identification products and requirements.
- F. Section 271005 - Structured Cabling for Voice and Data: Voice and data jacks.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NFPA 70 - National Electrical Code.
- C. UL 5 - Surface Metal Raceways and Fittings.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of raceways with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate rough-in locations of outlet boxes provided under Section 260535 and conduit provided under Section 260533 as required for installation of raceways provided under this section.
 - 3. Verify minimum sizes of raceways with the actual conductors and components to be installed.
 - 4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install raceways until final surface finishes and painting are complete.
 - 2. Do not begin installation of conductors and cables until installation of raceways is complete between outlet, junction and splicing points.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets including dimensions, knockout sizes and locations, materials, fabrication details, finishes, service condition requirements, and accessories.
 - 1. Surface Raceway Systems: Include information on fill capacities for conductors and cables.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 RACEWAY REQUIREMENTS

- A. Provide all components, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Do not use raceways for applications other than as permitted by NFPA 70 and product listing.

2.2 SURFACE RACEWAY SYSTEMS

- A. Manufacturers:
 - 1. Hubbell Incorporated: www.hubbell.com/#sle.
 - 2. MonoSystems, Inc: www.monosystems.com/#sle.
 - 3. Wiremold, a brand of Legrand North America, Inc: www.legrand.us/#sle.
- B. Surface Metal Raceways: Listed and labeled as complying with UL 5.
- C. Surface Raceway System:
 - 1. Raceways containing power conductors:
 - a. Wiremold 500 series, minimum, or equal.
 - b. Raceway Type: Single channel, painted steel.
 - c. Color: White.
 - 2. Products

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes and conduit terminations are installed in proper locations and are properly sized in accordance with NFPA 70 to accommodate raceways.
- C. Verify that mounting surfaces are ready to receive raceways and that final surface finishes are complete, including painting.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install raceways plumb and level.
- D. Arrange wireways and associated raceway connections to comply with NFPA 70, including but not limited to requirements for deflected conductors and wireways used as pullboxes. Increase size of wireway where necessary.
- E. Secure and support raceways in accordance with Section 260529 at intervals complying with NFPA 70 and manufacturer's requirements.
- F. Close unused raceway openings.
- G. Provide grounding and bonding in accordance with Section 260526.

3.3 FIELD QUALITY CONTROL

- A. Inspect raceways for damage and defects.
- B. Correct wiring deficiencies and replace damaged or defective raceways.

3.4 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.5 PROTECTION

- A. Protect installed raceways from subsequent construction operations.

END OF SECTION 260534

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SECTION 260535

BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260529 - Hangers and Supports.
- C. Section 260533 - Conduit:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- D. Section 260534 - Surface Raceways:
- E. Section 260553 - Identification: Identification products and requirements.
- F. Section 262726 - Wiring Devices:
 - 1. Wall plates.
 - 2. Additional requirements for locating boxes for wiring devices.
- G. Section 271005 - Structured Cabling for Voice and Data: Additional requirements for communications systems outlet boxes.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
- D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- E. NFPA 70 - National Electrical Code.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- G. UL 514A - Metallic Outlet Boxes.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 BOXES

A. General Requirements:

1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled as suitable for the purpose intended.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:

1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.

3. Use cast iron boxes or cast aluminum boxes, where exposed galvanized steel rigid metal conduit or exposed intermediate metal conduit (IMC) is used.
 4. Use suitable concrete type boxes where flush-mounted in concrete.
 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
 6. Use raised covers suitable for the type of wall construction and device configuration where required.
 7. Use shallow boxes where required by the type of wall construction.
 8. Do not use "through-wall" boxes designed for access from both sides of wall.
 9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 13. Minimum Box Size, Unless Otherwise Indicated:
 - a. Wiring Devices: 4 inch square by 2-1/8 inch deep (100 by 54 mm) trade size.
 - b. Ceiling Outlets: 4 inch octagonal or square by 2-1/8 inch deep (100 by 54 mm) trade size.
 14. Wall Plates: Comply with Section 262726.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 3R, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.

- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
 - 1. Provide raised covers suitable for device or device fitting without the need for an additional faceplate. Plaster ring covers are not acceptable.
- H. Box Locations:
 - 1. Locate boxes to be accessible. Provide access panels in accordance with Section 083100 as required where approved by the Architect.
 - 2. Unless dimensioned, box locations indicated are approximate.
 - 3. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 262726.
 - b. Communications Systems Outlets: Comply with Section 271005.
 - c. Fire Alarm Devices: Comply with Section 284600.
 - 4. Locate boxes so that wall plates do not span different building finishes.
 - 5. Locate boxes so that wall plates do not cross masonry joints.
 - 6. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 7. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 8. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 9. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 - 10. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 260533.
 - 11. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.

2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

O. Close unused box openings.

P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

Q. Provide grounding and bonding in accordance with Section 260526.

R. Identify boxes in accordance with Section 260553.

S. Secure flush mounting box to interior wall and partition studs with external to box fasteners. Accurately position to allow for surface finish thickness.

3.3 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.4 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION 260535

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SECTION 260553

IDENTIFICATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Underground warning tape.
- D. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Section 099113 - Exterior Painting.
- B. Section 099123 - Interior Painting.
- C. Section 260519 - Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- D. Section 262726 - Wiring Devices

1.3 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 - National Electrical Code.
- D. UL 969 - Marking and Labeling Systems.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.6 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil. Contractor shall coordinate with the Owner and use actual room numbers for circuit directory and not the room numbers on the drawings.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - b. Transformers:
 - 1) Identify power source and circuit number. Include location.
 - 2) Identify load(s) served. Include location when not within sight of equipment.
 - c. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served.
 - 2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - 3. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
 - 4. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
 - 5. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
 - 6. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.

7. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".

C. Identification for Conductors and Cables:

1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
2. Use underground warning tape to identify direct buried cables.

D. Identification for Boxes:

1. Use voltage markers or color coded boxes to identify systems other than normal power system.
 - a. Color-Coded Boxes: Field-painted in accordance with Section 099123 and 099113 per the same color code used for raceways.
2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.

E. Identification for Devices:

1. Wiring Device and Wallplate Finishes: Comply with Section 262726.
2. Use identification label to identify fire alarm system devices.
3. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
4. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
5. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.

- a. Use only for indoor locations.
 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend:
 - a. System designation where applicable:
 - b. Equipment designation or other approved description.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. System Designation: 1 inch.
 - b. Equipment Designation: 1/2 inch.
 - c. Other Information: 1/4 inch.
 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/4 inch.
 5. Color: Black text on white background unless otherwise indicated.
- E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/2 inch.
 5. Color: Black text on yellow background unless otherwise indicated.

2.3 UNDERGROUND WARNING TAPE

- A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color:
 1. Tape for Buried Power Lines: Black text on red background.
 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.4 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
- C. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Boxes: Outside face of cover.
 - 8. Conductors and Cables: Legible from the point of access.
 - 9. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

- F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
- G. Secure rigid signs using stainless steel screws.
- H. Mark all handwritten text, where permitted, to be neat and legible.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

SECTION 260583
WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Conductors and Cables.
- B. Section 260533 - Conduit.
- C. Section 260535 - Boxes.
- D. Section 262726 - Wiring Devices.
- E. Section 262817 - Enclosed Switches.
- F. Section 262913 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices.
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- C. NFPA 70 - National Electrical Code.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.5 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Disconnect Switches: As specified in Section 262817 and in individual equipment sections.
- C. Flexible Conduit: As specified in Section 260533.
- D. Wire and Cable: As specified in Section 260519.
- E. Boxes: As specified in Section 260535.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

SECTION 260923
LIGHTING CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Lighting Control System
- B. Indoor motion sensors
- C. Outdoor photo controls.
- D. Functional Testing
- E. Cabling
- F. Low-Voltage Switches

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding
- B. Section 260529 - Hangers and Supports
- C. Section 260533 - Conduit
- D. Section 260535 - Boxes

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- C. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices.
- D. NFPA 70 - National Electrical Code.
- E. UL 1472 - Solid-State Dimming Controls.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 2. Coordinate the placement of wall switch motion sensors with actual installed door swings.
 - 3. Coordinate the placement of motion sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.

4. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

C. Pre-Wire Meeting:

1. Include the services of a factory trained technician to attend and facilitate an on-site pre-wire meeting to review system installation requirements.
2. Schedule meeting to occur after receipt of final shop drawings.

1.5 SUBMITTALS

- A. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features of products being provided.

B. Shop Drawings:

1. Provide lighting plan, drawn to scale, indicating location and model number of each device, accessory, and component being provided that is required for a complete and operational system.
2. Interconnection diagram of field installed wiring.
3. Engraved labeling forms for low voltage switches, where required.

C. Functional Testing checklists and documentation indicating:

1. List of lighting control components to be tested.
2. Quantity of each type of component tested.
3. Refer to the "Functional Testing" paragraph in this specification for additional information.

- D. Operation and Maintenance Data: Include detailed information on device programming and setup.

1. Include Function Testing report of tested components.
 - a. Include results of each tested component and corrective action, if needed.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. Provide five year manufacturer warranty for lighting control components.

PART 2 PRODUCTS

2.1 LIGHTING CONTROL SYSTEM - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as recommended by the manufacturer and as required for a complete operating system.
- C. Products for Switching of Electronic Ballasts/Drivers: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.
- D. Motion sensors indicated on the drawings are for coordination only and are a minimum. Provide additional sensors as required for full room coverage. Coordinate ceiling heights with Architectural Reflected Ceiling Plans, where present.
- E. System Description: Non-networked, low voltage, analog standalone devices that control lighting indicated on the drawings.
- F. Provide system consisting of wired components. Wireless is not permitted.
- G. Where dimming is indicated on the drawings, provide a continuous flicker-free dimming system.

2.2 MANUFACTURERS

- A. Acuity Brands Lighting; nLight: www.acuitybrands.com
- B. WattStopper; DLM; www.legrand.us/wattstopper
- C. Hubbell; NX Distributed Intelligence; www.hubbell.com
- D. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
- E. Substitutions and Prior Approval Requests: Manufacturers not listed will be considered as a prior approval or substitution request. Provide the following:
 - 1. Manufacturer's cut sheets for proposed components.
 - 2. Example wiring schematic.
 - 3. Upon request, a working sample.

2.3 INDOOR MOTION SENSORS

- A. All Indoor Motion Sensors:
 - 1. Provide the following type of sensor per area, unless indicated otherwise:
 - a. Offices: Dual Technology
 - b. Classrooms: Dual Technology
 - c. Restrooms: Ultrasonic or microphonic

- d. Corridors & Vestibules: Passive Infrared
- e. Other Areas: As recommended by the manufacturer
- 2. Provide type of sensor per area as recommended by the manufacturer.
- 3. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
- 4. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
- 5. Operation: Unless otherwise indicated, motion sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
- 6. Dual Technology Motion Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
- 7. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
- 8. Turn-Off Delay: Field adjustable, with time delay settings up to 20 minutes.
- 9. Sensitivity: Field adjustable.
- 10. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
- 11. Load Rating for Line Voltage Motion Sensors: As required to control the load indicated on drawings.
- 12. Isolated Relay for Low Voltage Motion Sensors: SPDT dry contacts, ratings as required for interface with system indicated.

B. Wall Switch Motion Sensors:

- 1. Description: Motion sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
- 2. Unless otherwise indicated or required to control the load indicated on drawings, provide line voltage units with self-contained relay.
- 3. Where indicated, provide two-circuit units for control of two separate lighting loads, with separate manual controls and separately programmable operation for each load.
- 4. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
- 5. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
- 6. Finish: Match finishes specified for wiring devices in Section 262726, unless otherwise indicated.

C. Wall Dimmer Motion Sensors:

- 1. Description: Motion sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.

2. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
3. Manual-Off Override Control Capability: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
4. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
5. Provide field adjustable dimming preset for occupied state.
6. Finish: Match finishes specified for wiring devices in Section 262726, unless otherwise indicated.

D. Ceiling Mounted Motion Sensors:

1. Description: Low profile motion sensors designed for ceiling installation.
2. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
3. Provide field selectable setting for disabling LED motion detector visual indicator.
4. Motion sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
5. Finish: White unless otherwise indicated.

E. Directional Motion Sensors:

1. Designed for wall or ceiling mounting, with integral swivel for field adjustment of motion detection coverage.
 - a. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - b. Provide field selectable setting for disabling LED motion detector visual indicator.
 - c. Finish: White unless otherwise indicated.

F. Luminaire Mounted Motion Sensors: Designed for direct luminaire installation and control, suitable for use with specified luminaires.

1. Accessories:
 - a. Provide mounting bracket for lowering motion sensor such that luminaire does not block sensor field of view where required.

G. Power Packs for Low Voltage Motion Sensors:

1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage motion sensors for switching of line voltage loads.
2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
3. Input Supply Voltage: Dual rated for 120/277 V ac.
4. Load Rating: As required to control the load indicated on drawings.

2.4 OUTDOOR PHOTO CONTROLS

A. Manufacturers:

1. Intermatic, Inc: www.intermatic.com/#sle.

2. Same manufacturer of lighting control system where network system is indicated on the drawings.
3. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. System Description:

1. Stand alone or networked, where indicated, control system consisting of photosensors and compatible load controllers, contactors, or relays as required for automatic control of exterior lighting loads indicated according to available natural light.

C. Outdoor Light Level Sensors:

1. Listed and Labeled as complying with UL 773A.
2. Housing: Weatherproof, impact resistant polycarbonate.
3. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
4. Voltage: As required to control the load indicated on the drawings.
5. Failure Mode: Fails to the on position.
6. Load Rating: As required to control the load indicated on the drawings.
7. Provide accessory wall-mounting bracket where indicated or as required to complete installation.

2.5 CABLING

- A. Provide cabling as recommended by the manufacturer. Install all cabling in conduit.

2.6 LOW-VOLTAGE SWITCHES

- A. Provide switches and associated wiring and/or cabling compatible with system being provided.
- B. Low-voltage switches shall be provided with backboxes and mounting hardware as required for installation.
- C. Device finish and wall plate color shall be provided as specified in Section 262726 - Wiring Devices
- D. Engraved labeling:
1. Low-voltage switches shall have each button labeled with associated function, such as "ON" and "OFF". Dimming, where indicated, shall be identified at each button with associated function, such as "RAISE", "LOWER", raise/lower symbol, or similar.
 2. Labeling of buttons shall be provided by factory engraving. Provide engraving with a color that is in contrast to the device color for legibility and visual identification. Adhesive labels are not permitted.
 3. Where low-voltage switches are not within sight of the load controlled, they shall be provided with an identification label indicating load controlled in addition to a visual light indicator that indicates load on/off status. Refer to Section 260553 - Identification.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260535 as required for installation of lighting control devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Motion Sensors: 46 Inches above finished floor.
 - b. In-Wall Time Switches: 46 inches above finished floor.
 - 2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
 - 3. Locate wall switch motion sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.
- C. Install lighting control devices in accordance with manufacturer's instructions.
- D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- E. Install lighting control devices plumb and level, and held securely in place.

- F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 262726.
- G. Provide required supports in accordance with Section 260529.
- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Motion Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
 - 2. Locate ultrasonic and dual technology passive infrared/ultrasonic motion sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- J. Outdoor Photo Control Locations:
 - 1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
 - 2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.
- K. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.
- L. Install wiring in the following locations in conduit in accordance with Section 26 0534:
 - 1. All applications using 0-10v wiring.
 - 2. Within walls.
 - 3. Above inaccessible ceilings.
 - 4. Within hollow spaces used as air handling ducts and plenums.
 - 5. Exposed along surfaces.
 - 6. Where installed outside the building.
 - 7. Where exposed to damage.
 - 8. Where installed in areas with exposed structure ceiling.
 - 9. In gymnasiums.
- M. Cabling not installed in conduit shall be supported from structure with J-hook cable hangers or Velcro cable straps. DO NOT support cabling from duct work, piping, ceiling grid wires, ceiling tiles, etc. Provide plenum rated cable where required.
- N. Unless otherwise indicated, install emergency lighting relays and power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.
- O. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.

- P. Unless otherwise indicated, install line voltage switches, where present, on load side of power packs so that switch does not turn off power pack.
- Q. Maintain separation of normal and emergency branch circuit wiring connected to emergency lighting relays as required by NFPA 70. Normal and emergency branch circuits can be combined only within the emergency lighting relay enclosure.

3.4 SYSTEM STARTUP AND PROGRAMMING

- A. Coordinate system programming and device engraving with the Owner.
- B. Provide factory startup and programming of the system. Program according to Owner's requirements.
- C. Coordinate high end and/or low end trim levels with Owner and Architect/Engineer during system programming.
- D. Programming shall be completed prior to final verification walkthrough by the design team and shall be completed prior to completion of each phase, if applicable. Coordinate project phasing with project schedule and general contractor.

3.5 FIELD QUALITY CONTROL

- A. Inspect each lighting control device for damage and defects.
- B. Test motion sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.
- C. Test outdoor photo controls to verify proper operation, including time delays where applicable.
- D. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.6 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust motion sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Engineer.
- C. Adjust position of outdoor motion sensors and directional motion sensors to achieve optimal coverage as required.
- D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology motion sensor lenses to block undesired motion detection.

3.7 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.8 FUNCTIONAL TESTING

- A. Minimum equipment and systems indicated in this "Functional Testing" paragraph are subject to functional testing beyond final verification and punch lists.
- B. The contractor shall provide Functional Testing after system startup and programming by a manufacturer's authorized technician, calibrated to perform per the construction documents, and prior to the engineer's final verification and punch lists.
- C. Provide all standard testing equipment required to perform startup and functional performance testing. Equipment and software required to perform functional testing and future adjustments shall become property of the owner at no additional cost after project bid.
- D. Provide checklists and written documentation of all systems and individual components.
- E. The engineer and Owner's representative shall be notified seven (7) days in advance and given the opportunity to be present for all testing.
- F. Systems and components to be functional tested:
 - 1. Lighting Controls:
 - a. Occupancy Sensors:
 - 1) Certify that the occupant sensor has been located and aimed in accordance with manufacturer recommendations.
 - 2) For projects with seven or fewer occupant sensors, each sensor shall be tested to function per the construction documents.
 - 3) For projects with more than seven occupant sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10 percent and in no case fewer than one, of each combination shall be tested unless the code official or design team requires a higher percentage to be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested.
 - 4) For occupant sensor controls to be tested, verify the following:
 - (a) Where occupant sensor controls include status indicators, verify correct operation.
 - (b) The controlled lights turn off or down to the permitted level within the required time.
 - (c) For auto-on occupant sensor controls, the lights turn on to the permitted level when an occupant enters the space.
 - (d) For manual-on occupant sensor controls, the lights turn on only when manually activated.
 - (e) The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.
- G. Checklists and test report documentation shall be submitted by the contractor to confirm the functional testing has been completed. Submit checklists and documentation for engineer review prior to final walkthrough and punch list.

3.9 CLOSEOUT ACTIVITIES

- A. Training: Prior to substantial completion, train Owner's personnel on operation, adjustment, programming, and maintenance of fully operational lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's authorized service representative.
 - 4. Location: At project site.

3.10 MAINTENANCE

- A. Within one year of Substantial Completion, provide on-site assistance by a manufacturer's authorized service representative to make system adjustments or to provide training. Provide up to three visits, at approximately three, six, and twelve, months after substantial completion for this purpose.
- B. Six months after Substantial Completion, provide training to retrain the Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices. Make any necessary adjustments to the system based upon owner and design team input.

END OF SECTION 260923

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SECTION 262200

TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General purpose transformers.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260526 - Grounding and Bonding.
- C. Section 260529 - Hangers and Supports.
- D. Section 260533 - Conduit: Flexible conduit connections.
- E. Section 260553 - Identification: Identification products and requirements.
- F. Section 262416 - Panelboards.

1.3 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers.
- B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers.
- C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers.
- F. NEMA ST 20 - Dry-Type Transformers for General Applications.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- H. NFPA 70 - National Electrical Code.
- I. UL 506 - Standard for Specialty Transformers.
- J. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
3. Coordinate the work with placement of supports, anchors, etc. required for mounting.
4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Include voltage, kVA, impedance, tap configurations, insulation system class and rated temperature rise, efficiency, sound level, enclosure ratings, outline and support point dimensions, weight, required clearances, service condition requirements, and installed features.
1. Vibration Isolators: Include attachment method and rated load and deflection.
- B. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- C. Project Record Documents: Record actual locations of transformers.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.geindustrial.com/#sle.
- B. Eaton Corporation: www.eaton.com.

- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- E. Source Limitations: Furnish transformers produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:
 - 1. Altitude: Less than 3,300 feet.
 - 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
 - 3. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Primary Voltage: 480 volts delta, 3 phase.
- C. Secondary Voltage: 208Y/120 volts, 3 phase.
- D. Insulation System and Allowable Average Winding Temperature Rise:
 - 1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.

2. 15 kVA and Larger: Class 220 degrees C insulation system with 80 degrees C average winding temperature rise.
- E. Coil Conductors: Continuous copper windings with terminations brazed or welded.
- F. Winding Taps:
 1. Less than 3 kVA: None.
 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.
 4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- G. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- H. Sound Levels: Standard sound levels complying with NEMA ST 20
- I. Mounting Provisions:
 1. Less than 15 kVA: Suitable for wall mounting.
 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 3. Larger than 75 kVA: Suitable for floor mounting.
- J. Transformer Enclosure: Comply with NEMA ST 20.
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor clean, dry locations: Type 2.
 - b. Outdoor locations: Type 3R.
 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 4. Provide lifting eyes or brackets.
- K. Accessories:
 1. Mounting Brackets: Provide manufacturer's standard brackets.
 2. Lug Kits: Sized as required for termination of conductors as indicated on the drawings.

2.4 SOURCE QUALITY CONTROL

- A. Factory test transformers according to NEMA ST 20.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that suitable support frames and anchors are installed where required and that mounting surfaces are ready to receive transformers.

- C. Perform pre-installation tests and inspections on transformers per manufacturer's instructions and as specified in NECA 409. Correct deficiencies prior to installation.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 260533, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Install transformers plumb and level.
- G. Transformer Support:
 - 1. Provide required support and attachment in accordance with Section 260529, where not furnished by transformer manufacturer.
 - 2. Use integral transformer flanges, accessory brackets furnished by manufacturer, or field-fabricated supports to support wall-mounted transformers.
 - 3. Unless otherwise indicated, mount floor-mounted transformers on properly sized 3 inch high concrete pad constructed in accordance with Section 033000.
 - 4. Use trapeze hangers assembled from threaded rods and metal channel (strut) to support suspended transformers. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- H. Provide grounding and bonding in accordance with Section 260526.
- I. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- J. Where not factory-installed, install lugs sized as required for termination of conductors as indicated.
- K. Identify transformers in accordance with Section 260553.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.

3.4 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from transformer components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262200

SECTION 262416

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 260526 - Grounding and Bonding.
- C. Section 260529 - Hangers and Supports.
- D. Section 260553 - Identification: Identification products and requirements.
- E. Section 262200 - Transformers: Small power centers with integral primary breaker, transformer, and panelboard.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards.
- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NEMA PB 1 - Panelboards.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NFPA 70 - National Electrical Code.
- H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- J. UL 67 - Panelboards.
- K. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

- L. UL 869A - Reference Standard for Service Equipment.
- M. UL 943 - Ground-Fault Circuit-Interrupters.
- N. UL 1699 - Arc-Fault Circuit-Interrupters.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
 - 1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
- B. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. 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.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.geindustrial.com/#sle.
- B. Eaton Corporation: www.eaton.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
 - 2. Listed series ratings are not acceptable.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- H. Conductor Terminations: Lugs rated 60/75-deg. C or 75-deg C.
- I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.

- b. Outdoor Locations: Type 3R.
- 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - b. Increase gutter space as required where sub-feed lugs, feed-through lugs, gutter taps, or oversized lugs are provided.
- 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
- 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Arc Flash Energy-Reducing Maintenance Switching: For circuit breakers rated 1200 A or higher, or circuit breakers that can be adjusted to 1,200A, provide a local accessory switch with status indicator light that permits selection of a maintenance mode with alternate electronic trip unit settings for reduced fault clearing time.
- L. Multi-Section Panelboards: Provide enclosures of the same height, with feed-through lugs or sub-feed lugs and feeders as indicated or as required to interconnect sections.
- M. Load centers are not acceptable.
- N. Provide the following features and accessories where indicated or where required to complete installation:
 - 1. Feed-through lugs.
 - 2. Sub-feed lugs.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Products:
 - 1. Square D: I-Line or equal.
- C. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
 - 3. Lugs rated for 60/75-deg. C or 75-deg. C.
- D. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.

E. Circuit Breakers:

1. Provide bolt-on type.
2. Provide thermal magnetic circuit breakers unless otherwise indicated.
3. Provide electronic trip circuit breakers where indicated.

F. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide trims to cover access to load terminals, wiring gutters, and other live parts, with exposed access to overcurrent protective device handles.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Conductor Terminations:

1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
2. Main and Neutral Lug Type: Mechanical.
3. Lugs rated for 60/75-deg. C or 75-deg. C.

C. Bussing:

1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
2. Phase and Neutral Bus Material: Copper.
3. Ground Bus Material: Copper.

D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

E. Enclosures:

1. Provide surface-mounted or flush-mounted enclosures as indicated.
2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
3. Provide clear plastic circuit directory holder mounted on inside of door.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.

- 2) 14,000 rms symmetrical amperes at 480 VAC.
- b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger in lighting and appliance panelboards.
 - b. Provide interchangeable trip units where indicated.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide electronic trip breaker for all circuit breakers 225 amperes and larger in power distribution panelboards.
 - b. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Instantaneous pickup.
 - 5) Ground fault pickup and delay where ground fault protection is indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - b. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
8. Do not use tandem circuit breakers.
9. Do not use handle ties in lieu of multi-pole circuit breakers.
10. Provide multi-pole circuit breakers for multi-wire branch circuits as required by NFPA 70.
11. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.6 SOURCE QUALITY CONTROL

- A. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.

- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Power distribution panels installed within 6" of the finished floor shall be floor mounted on a 3.5 inch high concrete housekeeping pad. Coordinate panel size and mounting requirements with equipment supplier.
- J. Mount floor-mounted power distribution panelboards on properly sized 3.5 inch high concrete pad constructed in accordance with Section 033000.
- K. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.
- L. Provide grounding and bonding in accordance with Section 260526.
- M. Install all field-installed branch devices, components, and accessories.
- N. Multi-Wire Branch Circuits: Group grounded and ungrounded conductors together in the panelboard as required by NFPA 70.
- O. Set field-adjustable circuit breaker tripping function settings as directed.
- P. Provide filler plates to cover unused spaces in panelboards.
- Q. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
 - 1. Fire detection and alarm circuits.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
- C. Test GFCI circuit breakers to verify proper operation.
- D. Test AFCI circuit breakers to verify proper operation.
- E. Test shunt trips to verify proper operation.
- F. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

- A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION 262416

SECTION 262726

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Receptacles.
- D. Wall plates.
- E. Floor box service fittings.

1.2 RELATED REQUIREMENTS

- A. Section 260519 - Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
- B. Section 260526 - Grounding and Bonding.
- C. Section 260535 - Boxes.
- D. Section 260553 - Identification: Identification products and requirements.
- E. Section 260923 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.
- F. Section 271005 - Structured Cabling for Voice and Data: Voice and data jacks.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Federal Specification.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Federal Specification.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices.
- F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
- G. NFPA 70 - National Electrical Code.
- H. UL 20 - General-Use Snap Switches.

- I. UL 498 - Attachment Plugs and Receptacles.
- J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.
- K. UL 943 - Ground-Fault Circuit-Interrupters.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
- 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
- 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
- 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
- 5. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

B. Sequencing:

- 1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

- 1. Wall Dimmers: Include derating information for ganged multiple devices.

B. Operation and Maintenance Data:

- 1. Wall Dimmers: Include information on operation and setting of presets.
- 2. GFCI Receptacles: Include information on status indicators.

1.6 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

C. Products: Listed, classified, and labeled as suitable for the purpose intended.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide GFI protection for all receptacles installed within 6 feet of sinks and other locations as required by the NEC.
- E. Provide GFCI protection for receptacles installed in kitchens.
- F. Provide GFCI protection for receptacles serving electric drinking fountains.
- G. For flush floor service fittings, use tile rings for installations in tile floors.
- H. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.2 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices Installed in Finished Spaces: White with white nylon wall plate.
- C. Wiring Devices Installed in Unfinished Spaces: Gray with galvanized steel wall plate.
- D. Wiring Devices Installed in Wet or Damp Locations: Gray with specified weatherproof cover.

2.3 WALL SWITCHES

- A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring with separate ground terminal screw.
- B. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

2.4 RECEPTACLES

- A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498 and where applicable FS W-C-596; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 - 2. NEMA configurations specified are according to NEMA WD 6.

B. Convenience Receptacles:

1. Tamper Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
2. Tamper Resistant and Weather Resistant Convenience Receptacles: Commercial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.

C. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
 - a. Provide test and reset buttons of same color as device.
2. Tamper Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
3. Tamper Resistant and Weather Resistant GFCI Receptacles: Commercial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

2.5 WALL PLATES

A. Wall Plates: Comply with UL 514D.

1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
2. Size: Standard.
3. Screws: Metal with slotted heads finished to match wall plate finish.
4. All screws shall be aligned in the same orientation on each faceplate.

B. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.

C. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.

D. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.

E. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

F. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Install hospital grade receptacles in all patient care areas, standard grade receptacles in other areas.

- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 260535 as required for installation of wiring devices provided under this section.
 - 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switches: 46 inches above finished floor to center of box.
 - b. Wall Dimmers: 46 inches above finished floor to center of box.
 - c. Receptacles: 18 inches above finished floor or 4 inches above top of counter/backsplash to center of box.
 - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate. Provide voltage separation as required.
 - 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Engineer to obtain direction prior to proceeding with work.
 - 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions. Ground fault device shall be installed in an accessible location.
- C. Install wiring devices in accordance with manufacturer's instructions.
- D. Connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- E. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

- F. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- G. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.
- H. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- I. Install wall switches with OFF position down.
- J. Where required by wall dimmer manufacturer provide separate conduit for 0-10V control conductors.
- K. Install vertically mounted receptacles with grounding pole on bottom and horizontally mounted receptacles with grounding pole on left.
- L. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- M. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- N. All receptacles and switches shall be identified with a label indicating the panel and circuit number feeding the device.

3.4 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
- D. Test each receptacle to verify operation and proper polarity.
- E. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- F. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 262726

SECTION 262813

FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.

1.2 RELATED REQUIREMENTS

- A. Section 260553 - Identification: Identification products and requirements.
- B. Section 262817 - Enclosed Switches: Fusible switches.
- C. Section 262913 - Enclosed Controllers: Fusible switches.

1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses.
- B. NFPA 70 - National Electrical Code.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.
- E. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses.
- F. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
 - a. Fusible Enclosed Switches: See Section 262817.
 - b. Fusible Switches for Enclosed Motor Controllers: See Section 262913.
 - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
 - 3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.

2. Extra Fuses: One set(s) of three for each type and size installed.
 - a. Obtain Owner's signature for extra fuses and provide a signed copy of the document to the Engineer.
3. Spare Fuse Cabinet Keys: Two.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Bussmann, a division of Eaton Corporation: www.cooperindustries.com.
- B. Littelfuse, Inc: www.littelfuse.com.
- C. Mersen: ep-us.mersen.com/#sle.

2.2 APPLICATIONS

- A. Feeders:
 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
 2. Fusible Switches Larger Than 600 Amperes: Class L, time-delay.
- B. General Purpose Branch Circuits: Class RK1, time-delay.
- C. Individual Motor Branch Circuits: Class RK1, time-delay.
- D. Primary Protection for Control Transformers: Class CC, time-delay.

2.3 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Indicator Feature: Provide fuses with indicating feature for visual troubleshooting, when available.

- G. Voltage Rating: Suitable for circuit voltage.
- H. Class R Fuses: Comply with UL 248-12.
 - 1. Class RK1, Time-Delay Fuses:
- I. Class L Fuses: Comply with UL 248-10.
- J. Class CC Fuses: Comply with UL 248-4.
- K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- L. Provide the following accessories where indicated or where required to complete installation:
 - 1. Fuseholders: Compatible with indicated fuses.
 - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet in convenient location in main electrical room unless otherwise indicated.
- D. Identify spare fuse cabinet in accordance with Section 260553.

END OF SECTION 262813

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SECTION 262817
ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260529 - Hangers and Supports.
- C. Section 260553 - Identification: Identification products and requirements.
- D. Section 262813 - Fuses.
- E. Section 262913 - Enclosed Controllers: Manual motor controllers.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- D. NFPA 70 - National Electrical Code.
- E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
- F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- G. UL 98 - Enclosed and Dead-Front Switches.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
- B. Project Record Documents: Record actual locations of enclosed switches.
- C. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed switch internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.geindustrial.com/#sle.
- B. Eaton Corporation: www.eaton.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.
- E. Source Limitations: Furnish enclosed switches and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Horsepower Rating: Suitable for connected load.
- D. Voltage Rating: Suitable for circuit voltage.
- E. Short Circuit Current Rating:

1. Provide enclosed safety switches, when protected by the fuses or supply side overcurrent protective devices to be installed, with listed short circuit current rating 100,000 rms symmetrical amperes..
 2. Minimum Ratings:
 - a. Heavy Duty Single Throw Switches Protected by Class R, Class J, Class L, or Class T
Fuses: 200,000 rms symmetrical amperes.
- F. Provide with switch blade contact position that is visible when the cover is open.
- G. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
1. Where NEMA Class R fuses are installed, provide rejection feature to prevent installation of fuses other than Class R.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.
- J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- M. Heavy Duty Switches:
1. Comply with NEMA KS 1.
 2. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Copper suitable for terminating copper conductors only.
 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.
- N. Provide the following features and accessories where indicated or where required to complete installation:
1. Hubs: As required for environment type; sized to accept conduits to be installed.
 2. Auxiliary Switch: SPDT switch suitable for connection to system indicated, with auxiliary contact operation before switch blades open and after switch blades close.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
- B. Verify that mounting surfaces are ready to receive enclosed safety switches.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 260526.
- H. Provide fuses complying with Section 262813 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Provide an identifying engraved nameplate describing what load the disconnect serves for each disconnect regardless of load location.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.
- B. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

SECTION 262913
ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed NEMA controllers for low-voltage (600 V and less) applications:
 - 1. Magnetic motor starters.
 - 2. General purpose contactors.
 - 3. Manual motor starters.
 - 4. Motor-starting switches without overload protection.
- B. Overcurrent protective devices for motor controllers, including overload relays.

1.2 RELATED REQUIREMENTS

- A. Section 260526 - Grounding and Bonding.
- B. Section 260529 - Hangers and Supports.
- C. Section 260553 - Identification: Identification products and requirements.
- D. Section 262813 - Fuses: Fuses for fusible switches.

1.3 REFERENCE STANDARDS

- A. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- E. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
- F. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
- G. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
- H. NFPA 70 - National Electrical Code.
- I. UL 98 - Enclosed and Dead-Front Switches.
- J. UL 60947-1 - Low-Voltage Switchgear and Controlgear - Part 1: General Rules.
- K. UL 60947-4-1 - Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-starters - Electromechanical Contactors and Motor-starters.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
2. Coordinate the work to provide motor controllers and associated overload relays suitable for use with the actual motors to be installed.
3. Coordinate the work to provide controllers and associated wiring suitable for interface with control devices to be installed.
4. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
5. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
6. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- B. Project Record Documents: Record actual installed locations of controllers and final equipment settings.
1. Include nameplate data of actual installed motors and associated overload relay selections and settings.
- C. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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.
- B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE: www.geindustrial.com/#sle.
- B. Eaton Corporation: www.eaton.com.
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.

2.2 ENCLOSED CONTROLLERS

- A. Provide enclosed controller assemblies consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Description: Enclosed controllers complying with NEMA ICS 2, and listed and labeled as complying with UL 60947-1 and UL 60947-4-1; ratings, configurations and features as indicated on the drawings.
- D. Service Conditions:
 - 1. Provide controllers and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude:
 - 1) Class 1 Km Equipment (devices utilizing power semiconductors, e.g. variable frequency controllers): Less than 3,300 feet.
 - 2) Class 2 Km Equipment (electromagnetic and manual devices): Less than 6,600 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 - 2. Provide controllers and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
- E. Short Circuit Current Rating:
 - 1. Provide controllers with listed short circuit current rating no less than 100,000 rms symmetrical amperes..
- F. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures:
 - 1. Comply with NEMA ICS 6.
 - 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1 or Type 12.
 - b. Outdoor Locations: Type 3R or Type 4.

3. Finish: Manufacturer's standard unless otherwise indicated.

I. Instrument Transformers:

1. Comply with IEEE C57.13.
2. Select suitable ratio, burden, and accuracy as required for connected devices.
3. Current Transformers: Connect secondaries to shorting terminal blocks.
4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

J. Magnetic Motor Starters: Combination type unless otherwise indicated.

1. Combination Magnetic Motor Starters: NEMA ICS 2, Class A combination motor controllers with magnetic contactor(s), externally operable disconnect and overload relay(s).
2. Configuration: Full-voltage non-reversing unless otherwise indicated.
3. Minimum Starter Size: NEMA Size 0.
4. Disconnects: Disconnect switch type.
 - a. Disconnect Switches: Fusible type unless otherwise indicated.
 - b. Provide externally operable handle with means for locking in the OFF position. Provide safety interlock to prevent opening the cover with the disconnect in the ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
5. Overload Relays: Solid-state type unless otherwise indicated.
6. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings.
 - b. Single-Speed, Non-Reversing Starters:
 - 1) Pushbuttons: START-STOP.
 - 2) Selector Switches: HAND/OFF/AUTO.
 - 3) Indicating Lights: Red ON, Green OFF.

K. Manual Motor Starters:

1. Description: NEMA ICS 2, Class A manually-operated motor controllers with overload relay(s).
2. Configuration: Non-reversing unless otherwise indicated.
3. Fractional-Horsepower Manual Motor Starters:
 - a. Furnish with toggle operator.
 - b. Overload Relays: Bimetallic or melting alloy thermal type.
 - c. Provide means for locking operator in the OFF position.
 - d. Furnish Red ON indicating light where not within sight of equipment.

L. Motor-Starting Switches: Horsepower-rated switches without overload protection; toggle operator.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:

1. Provide overload relays and, where applicable, associated current elements/heaters, selected according to actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
3. Trip-free operation.
4. Visible trip indication.
5. Resettable.
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
6. Solid-State Overload Relays:
 - a. Adjustable full load current.
 - b. Phase loss protection.
 - c. Phase imbalance protection.
 - d. Ambient temperature insensitive.
 - e. Thermal memory.
 - f. Trip test function.
 - g. Provide isolated alarm contact.

B. Fusible Disconnect Switches:

1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated on the drawings.
2. Fuse Clips: As required to accept indicated fuses.
3. Provide externally operable handle with means for locking in the OFF position. Provide means for locking switch cover in the closed position. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

2.4 CONTROL ACCESSORIES

A. Auxiliary Contacts:

1. Comply with NEMA ICS 5.
2. Provide number and type of contacts indicated or required to perform necessary functions, including holding (seal-in) circuit and interlocking, plus one normally open (NO) and one normally closed (NC) spare contact for each magnetic motor starter, minimum.

B. Pilot Devices:

1. Comply with NEMA ICS 5; heavy-duty type.
2. Pushbuttons: Unless otherwise indicated, provide momentary, non-illuminated type with flush button operator; normally open or normally closed as indicated or as required.
3. Selector Switches: Unless otherwise indicated, provide maintained, non-illuminated type with knob operator; number of switch positions as indicated or as required.
4. Indicating Lights: Push-to-test type unless otherwise indicated.
5. Provide LED lamp source for indicating lights and illuminated devices.

- C. Control and Timing Relays:
 - 1. Comply with NEMA ICS 5.
 - 2. Provide number and type of relays indicated or required to perform necessary functions.
- D. Control Power Transformers:
 - 1. Size to accommodate burden of contactor coil(s) and all connected auxiliary devices, plus 20 percent spare capacity.
 - 2. Include primary and secondary fuses.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that ratings of enclosed controllers are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive enclosed controllers.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install controllers in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 260529.
- E. Install enclosed controllers plumb and level.
- F. Provide grounding and bonding in accordance with Section 260526.
- G. Install all field-installed devices, components, and accessories.
- H. Provide fuses complying with Section 262813 for fusible switches as indicated.
- I. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J. Set field-adjustable controllers and associated components according to installed motor requirements, in accordance with manufacturer's recommendations and NFPA 70.
- K. Provide an identifying engraved nameplate describing what load the controller serves for each controller regardless of load location.

3.3 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements, for additional requirements.

- B. Correct deficiencies and replace damaged or defective enclosed controllers or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.5 CLEANING

- A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.
- B. Repair scratched or marred exterior surfaces to match original factory finish.

3.6 PROTECTION

- A. Protect installed enclosed controllers from subsequent construction operations.

END OF SECTION 262913

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SECTION 265100
INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires, including exterior building mounted luminaires
- B. Emergency lighting units.
- C. Exit signs.
- D. Drivers

1.2 RELATED REQUIREMENTS

- A. Section 260529 - Hangers and Supports.
- B. Section 260535 - Boxes.

1.3 REFERENCE STANDARDS

- A. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts.
- B. IES LM-63 - IESNA Standard File Format for Electronic Transfer of Photometric Data and Related Information.
- C. IES LM-79 - Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products.
- D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules.
- E. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems.
- F. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility.
- G. NFPA 70 - National Electrical Code.
- H. NFPA 101 - Life Safety Code.
- I. UL 924 - Emergency Lighting and Power Equipment.
- J. UL 935 - Fluorescent-Lamp Ballasts.
- K. UL 1598 - Luminaires.
- L. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

A. Shop Drawings:

1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide dimensioned drawing for each custom length luminaire.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.

1. Luminaires:

- a. Include estimated useful life, calculated based on IES LM-80 test data.
 - b. Include IES LM-79 test report upon request.
 - c. Include color temperature, CRI, luminaire input wattage and delivered lumen output.
 - d. Include color information based on IES TM-30 test upon request.
 - e. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IES LM-63 standard format upon request.
2. Emergency Power Supply Unit: Include output power rating.
3. Drivers: Include product data, dimming protocol, voltage and environmental rating.

C. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Drivers: Two percent of total quantity installed for each type, but not less than one of each type.

E. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.9 WARRANTY

- A. See Section 017700-Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for LED luminaires, including drivers.
- C. Provide five year pro-rata warranty for batteries for emergency lighting units.
- D. Provide ten year pro-rata warranty for batteries for self-powered exit signs.

PART 2 PRODUCTS

2.1 INTERIOR LUMINAIRES

- A. Furnish products as indicated in the Light Fixture Schedule included on the drawings.
- B. Substitutions and Prior Approval Requests: Light Fixtures not specified or listed as an alternate in the Light Fixture Schedule will be considered as a prior approval or substitution request. Provide and identify the following information with the manufacturer's cut sheet:
 - 1. Estimated useful life, calculated based on IES LM-80 test data.
 - 2. Delivered lumen output, calculated based on IES LM-79.
 - 3. Color temperature, CRI, luminaire input wattage and warranty.
 - 4. Color information, based on IES TM-30 test report.
 - 5. MacAdam Ellipse data, upon request.
 - 6. IES LM-79 report, LM-80 report, and TM-30 report, upon request.
 - 7. Photometric calculation comparison to the basis of design luminaire for the applicable project space/area, upon request.
 - 8. Deviations from the specified luminaire.
- C. Provide products that comply with requirements of NFPA 70.

- D. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- E. Provide products listed, classified, and labeled as suitable for the purpose intended.
- F. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, drivers, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- G. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- H. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- I. For continuous wall-to-wall luminaires, field verify exact wall-to-wall dimensions prior to ordering.
- J. Doors and frames: Free of light leaks
- K. Recessed Luminaires:
 - 1. Ceiling Compatibility: Comply with NEMA LE 4.
 - 2. Luminaires Recessed in Insulated Ceilings: Listed and labeled as IC-rated, suitable for direct contact with insulation and combustible materials.
 - 3. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.
- L. LED Luminaires:
 - 1. Components: UL 8750 recognized or listed as applicable.
 - 2. Tested in accordance with IES LM-79 and IES LM-80.
 - 3. LED Estimated Useful Life: Minimum of 50,000 hours at 80 percent lumen maintenance, calculated based on IES LM-80 test data.
- M. LED Luminaire Components: UL 8750 recognized or listed as applicable.
- N. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.2 EMERGENCY LIGHTING UNITS

- A. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- C. Battery:
 - 1. Size battery to supply all connected lamps, including emergency remote heads where indicated.

- D. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- E. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- F. Accessories:
 - 1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
 - 2. Provide compatible accessory wire guards where indicated.
 - 3. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.3 EXIT SIGNS

- A. Description: Exit signs and similar signs for special purpose applications such as area of refuge/rescue assistance.
- B. Description: Exit signs complying with NFPA 101 and applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single- or double-face as indicated or as required for installed location.
 - 2. Directional Arrows: As indicated or as required for installed location.
- C. Self-Powered Exit Signs:
 - 1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
 - 2. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
 - 3. Provide low-voltage disconnect to prevent battery damage from deep discharge.
- D. Accessories:
 - 1. Provide compatible accessory wire guards where indicated.

2.4 DRIVERS

- A. General Requirements:
 - 1. Provide drivers containing no polychlorinated biphenyls (PCBs).
 - 2. Minimum Efficiency/Efficacy: Provide drivers complying with all current applicable federal and state driver efficiency/efficacy standards.
 - 3. Drivers: Inrush currents not exceeding peak currents specified in NEMA 410.
- B. Dimmable LED Drivers:
 - 1. Dimming Range: Continuous dimming from 100 percent to ten percent relative light output unless dimming capability to lower level is indicated, without flicker.
 - 2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.5 EMERGENCY POWER SUPPLY UNITS

- A. Description: Self-contained emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- B. Compatibility:
 - 1. Drivers: Compatible with electronic, standard magnetic, energy saving, and dimming AC drivers, including those with end of lamp life shutdown circuits.
- C. Operation: Upon interruption of normal power source, solid-state control automatically switches connected fixtures to the emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- D. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.
- E. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status and field selectable audible alert.
- F. Accessories:
 - 1. Provide compatible accessory remote combination test switch/indicator light where indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Verify ceiling and wall details from general construction documents prior to ordering luminaires. Provide proper mounting accessories for the intended installation. Install fixture trim tight to surrounding surfaces. Secure to prevent movement.
- B. Coordinate locations of outlet boxes provided under Section 260535 as required for installation of luminaires provided under this section.
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- E. Provide required support and attachment in accordance with Section 260529.
- F. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- G. Light fixture whips shall not exceed 6-feet in length.
- H. Suspended Ceiling Mounted Luminaires:
 - 1. Do not use ceiling tiles to bear weight of luminaires.
 - 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 - 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
 - 4. Secure pendant-mounted luminaires to building structure.
 - 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 - 6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
 - 7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- I. Recessed Luminaires:
 - 1. Luminaires smaller than grid openings: Center in acoustical panels unless otherwise indicated on reflected ceiling plan. Provide supporting members as required.
 - 2. Install trims tight to mounting surface with no visible light leakage.
 - 3. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
 - 4. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
- J. Suspended Luminaires:
 - 1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
 - 2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
 - 3. Install canopies tight to mounting surface.

- 4. Unless otherwise indicated, support pendants from swivel hangers.
- K. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- L. Surface Mounted Luminaires:
 - 1. Mount tight to surrounding surfaces.
 - 2. Locate outlet boxes in finished areas so they are concealed by luminaires.
- M. Install accessories furnished with each luminaire.
- N. Bond products and metal accessories to branch circuit equipment grounding conductor.
- O. Emergency Lighting Units:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- P. Exit Signs:
 - 1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
- Q. Emergency Power Supply Units:
 - 1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install on top of luminaire.
 - 2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
- R. Remote Drivers: Install in accessible location as indicated or as required to complete installation, using conductors per manufacturer's recommendations not exceeding manufacturer's recommended maximum conductor length to luminaire.
- S. Install lamps in each luminaire.
- T. Lamp Burn-In: Operate lamps at full output for a minimum 100hrs or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

3.4 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.
- B. Operate each luminaire after installation and connection to verify proper operation.
- C. Test self-powered exit signs, emergency lighting units, and emergency power supply units to verify proper operation upon loss of normal power supply.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Engineer or authority having jurisdiction.
- C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.
- B. Just prior to Substantial Completion, review proper operation of luminaires and correct deficiencies or make adjustments as required. Replace failed components as required.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265100

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SECTION 284600

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.
- B. Transmitters for communication with supervising station.
- C. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.
- D. Maintenance of fire alarm system under contract for specified warranty period.

1.2 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines.
- B. ADA Standards - 2010 ADA Standards for Accessible Design.
- C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
- D. NFPA 70 - National Electrical Code.
- E. NFPA 72 - National Fire Alarm and Signaling Code.
- F. NFPA 101 - Life Safety Code.
- G. UL 268 - Standard for Smoke Detectors for Fire Alarm Systems.
- H. IBC - International Building Code
- I. IFC - International Fire Code

1.3 SUBMITTALS

- A. Evidence of designer qualifications.
- B. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.

5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 11. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
 12. Certification by Contractor that the system design complies with Contract Documents.
 13. Do not show existing components to be removed.
- C. Evidence of installer qualifications.
- D. Shop Drawings: Shall include:
1. Design Documents, after approval by the Authority having jurisdiction.
 2. Designer Qualifications
 3. Installer qualifications
 4. Product Data
- E. Evidence of instructor qualifications; training lesson plan outline.
- F. Evidence of maintenance contractor qualifications, if different from installer.
- G. Inspection and Test Reports:
1. Submit inspection and test plan prior to closeout demonstration.
 2. Submit documentation of satisfactory inspections and tests.
 3. Submit NFPA 72 "Inspection and Test Form," filled out.
- H. Operating and Maintenance Data: See Section 017700 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
1. Complete set of specified design documents, as approved by authority having jurisdiction.
 2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
 3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
 4. List of recommended spare parts, tools, and instruments for testing.
 5. Replacement parts list with current prices, and source of supply.
 6. Detailed troubleshooting guide and large scale input/output matrix.
 7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.

8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.
- I. Project Record Documents: See Section 017700 for additional requirements; have one set available during closeout demonstration:
 1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
 2. "As installed" wiring and schematic diagrams, with final terminal identifications.
 3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.
- J. Closeout Documents:
 1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
 2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.
 3. Maintenance contract.
- K. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
 1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.
 2. In addition to the items in quantities indicated in PART 2, furnish the following:
 - a. One copy, on CD-ROM, of all software not resident in read-only-memory.
 - b. Extra Fuses: Two for each installed fuse; store inside applicable control cabinet.

1.4 QUALITY ASSURANCE

- A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.
- B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
 3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.
- C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

- D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 WARRANTY

- A. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for minimum 2 years after date of Substantial Completion.
- B. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Alarm Control Units - Basis of Design: Edwards EST-4
- B. Fire Alarm Control Units and Accessories:
 - 1. Honeywell Security & Fire Solutions/Gamewell-FCI: www.gamewell-fci.com/#sle.
 - 2. Honeywell Security & Fire Solutions/Notifier: www.notifier.com.
 - 3. Provide control units made by the same manufacturer.
- C. Initiating Devices and Notification Appliances:
 - 1. Same manufacturer as control units.
- D. Substitutions: See Section 016000 - Product Requirements.
 - 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
 - 2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.2 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 - 2. Protected Premises: Entire building shown on drawings.
 - 3. Comply with the following; where requirements conflict, the most stringent shall apply.
 - a. ADA Standards.
 - b. The requirements of the State Fire Marshal.
 - c. The requirements of the local authority having jurisdiction .
 - d. Applicable local codes.
 - e. Contract Documents (drawings and specifications).
 - f. NFPA 101.

- g. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - h. International Fire Code
 - 4. Evacuation Alarm: Single smoke zone; general evacuation of entire premises.
 - 5. Voice Notification: Provide emergency voice/alarm communications with multichannel capability; digital.
 - 6. Program notification zones and voice messages as directed by Owner.
 - 7. Hearing Impaired Occupants: Provide visible notification devices in all public areas and in sleeping units.
 - 8. Master Control Unit (Panel): New, located at where shown on the plans.
- B. Provide system with Mass Notification capabilities. The system shall have auxiliary contacts for campus wide mass notification to trigger up to five (5) pre-programmed alerts. Notification for mass notification shall be using fire alarm speakers, with blue or amber strobes. Blue = Weather events, Amber = Threat events.
- C. Supervising Stations and Fire Department Connections:
 - 1. Public Fire Department Notification: By remote supervising station.
 - 2. Remote Supervising Station: UL-listed central station under contract to facility.
 - 3. Means of Transmission to Remote Supervising Station: Digital alarm communicator transmitter (DACT), DMP DualCOM IP.
 - 4. Auxiliary Connection Type: Local energy.
- D. Circuits:
 - 1. Initiating Device Circuits (IDC): Class B, Style A.
 - 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 - 3. Notification Appliance Circuits (NAC): Class B, Style W.
- E. Spare Capacity:
 - 1. Initiating Device Circuits: Minimum 25 percent spare capacity.
 - 2. Notification Appliance Circuits: Minimum 25 percent spare capacity.
 - 3. Speaker Amplifiers: Minimum 25 percent spare capacity.
 - 4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
- F. Power Sources:
 - 1. Primary: Dedicated branch circuits of the facility power distribution system.
 - 2. Secondary: Storage batteries.
 - 3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.
 - 4. Each Computer System: Provide uninterruptible power supply (UPS).

2.3 EXISTING COMPONENTS

- A. Existing Fire Alarm System: Remove existing system completely after new system is fully operational and tested.
- B. Clearly label components that are "Not In Service."

- C. Remove unused existing components and materials from site and dispose of properly.

2.4 FIRE SAFETY SYSTEMS INTERFACES

- A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
 - 1. Sprinkler water control valves.
- B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
 - 1. Sprinkler water flow.
 - 2. Kitchen hood suppression activation; also disconnect fuel source from cooking equipment.
 - 3. Duct smoke detectors.
- C. HVAC:
 - 1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
 - a. Provide remote test station for any duct detector not readily accessible as required by NFPA.
- D. Doors:
 - 1. Smoke Barrier Door Magnetic Holders: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 087100.
 - 2. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 087100.
 - 3. Overhead Coiling Fire Doors: Release upon activation of smoke detectors in smoke zone on either side of door, upon alarm from manual pull station on same floor, and upon sprinkler activation on same floor. Refer to Section 083323.

2.5 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 - a. Surface mounted devices shall be provided with matching backbox from same manufacturer.
 - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
- C. Addressable Modules:
 - 1. Provide addressable modules suitable for connection to fire alarm control unit signaling line circuits.
 - 2. Unless otherwise indicated, use addressable modules only in clean, dry, indoor, nonhazardous locations.

3. Monitor Modules: Unless devices are explicitly permitted to be connected together as zone, provide separate addressable monitor module for each conventional dry-contact input device in order to be individually identifiable by addressable fire alarm control unit.
 4. Relay Modules: Provide as indicated or as required to perform necessary functions via dry-contact interface. Where load exceeds module contact rating, provide accessory power isolation relays suitable for load as required.
- D. Initiating Devices:
1. Addressable Systems:
 - a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
 - b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
 2. Manual Pull Stations: Double Action with Polycarbonate Covers.
- E. Notification Appliances:
1. Device Colors
 - a. Wall Mounted: White
 - b. Ceiling Mounted: White
 - c. Exterior: Red
- F. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.
- G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.
1. Equipment Connected to Alternating Current Circuits: Maximum let through voltage of 350 V(ac), line-to-neutral, and 350 V(ac), line-to-line; do not use fuses.
 2. Initiating Device Circuits, Notification Appliance Circuits, and Communications Circuits: Provide surge protection at each point where circuit exits or enters a building; rated to protect applicable equipment; for 24 V(dc) maximum dc clamping voltage of 36 V(dc), line-to-ground, and 72 V(dc), line-to-line.
 3. Signaling Line Circuits: Provide surge protection at each point where circuit exits or enters a building, rated to protect applicable equipment.
- H. Locks and Keys: Deliver keys to Owner.
1. Provide the same standard lock and key for each key operated switch and lockable panel and cabinet; provide 5 keys of each type
- I. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
 2. Provide one for each control unit where operations are to be performed.
 3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
 4. Provide extra copy with operation and maintenance data submittal.

3.3 OWNER PERSONNEL INSTRUCTION

- A. Provide the following instruction to designated Owner personnel:
 - 1. Hands-On Instruction: On-site, using operational system.
- B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
 - 1. Initial Training: 1 session pre-closeout.
- C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
 - 1. Initial Training: 1 session pre-closeout.
- D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.4 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.
 - 2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
 - 3. Have authorized technical representative of control unit manufacturer present during demonstration.
 - 4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
 - 5. Repeat demonstration until successful.
- B. Substantial Completion of the project cannot be achieved until inspection and testing is successful and:
 - 1. Specified diagnostic period without malfunction has been completed.
 - 2. Approved operating and maintenance data has been delivered.
 - 3. Spare parts, extra materials, and tools have been delivered.
 - 4. All aspects of operation have been demonstrated to Owner.
 - 5. Final acceptance of the fire alarm system has been given by authorities having jurisdiction.
 - 6. Specified pre-closeout instruction is complete.

3.5 MAINTENANCE

- A. See Section 017000 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, at no extra cost, a written maintenance contract for 2 years, to include the work described below.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. All wiring installed in exposed areas or above non-accessible ceilings or in walls shall be installed in conduit.
- D. Obtain Owner's approval of locations of devices, before installation.
 - 1. Install wall mounted strobes at 80" to the bottom.
 - 2. Install manual pull stations at 48" to the top. Align with adjacent light switches, where applicable.
- E. Install instruction cards and labels.
- F. Provide identification labels for all addressable devices.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.
- H. Diagnostic Period: After successful completion of inspections and tests, Operate system in normal mode for at least 14 days without any system or equipment malfunctions.
 - 1. Record all system operations and malfunctions.
 - 2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
 - 3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
 - 4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

- C. Perform routine inspection, testing, and preventive maintenance required by NFPA 72, including:
 - 1. Maintenance of fire safety interface and supervisory devices connected to fire alarm system.
 - 2. Repairs required, unless due to improper use, accidents, or negligence beyond the control of the maintenance contractor.
 - 3. Record keeping required by NFPA 72 and authorities having jurisdiction.
- D. Provide trouble call-back service upon notification by Owner:
 - 1. Provide on-site response within 2 hours of notification.
 - 2. Include allowance for call-back service during normal working hours at no extra cost to Owner.
 - 3. Owner will pay for call-back service outside of normal working hours on an hourly basis, based on actual time spent at site and not including travel time; include hourly rate and definition of normal working hours in maintenance contract.
- E. Provide a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.
- F. Maintain a log at each fire alarm control unit, listing the date and time of each inspection and call-back visit, the condition of the system, nature of the trouble, correction performed, and parts replaced. Submit duplicate of each log entry to Owner's representative upon completion of site visit.
- G. Comply with Owner's requirements for access to facility and security.

END OF SECTION 284600

SECTION 323132

WOOD COMPOSITE FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wood composite fences.
- B. Wood composite gates.
- C. Excavation for posts.

1.02 RELATED SECTIONS

- A. Section 03 30 00 - Cast-in-Place Concrete.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 - Submittal Procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used indicating sizes, profiles, surface finishes, and performance characteristics, and including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Instructions on care and cleaning of composite wood products.
- C. Verification Samples: For each finish product specified, two samples, minimum size 9 inches (229 mm) square, representing actual product, color, and patterns.
- D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- E. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for cleaning and maintenance.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle products in accordance with the manufacturer's instructions.
- B. Store level and flat, off ground or floor, with supports at each end and maximum 24 inches on center.
- C. Do not stack wood composite over 8 feet (203 mm) high.
- D. Cover wood composite with waterproof covering, vented to prevent moisture buildup.

1.05 WARRANTY

- A. Provide manufacturer's 25-year residential warranty / 10 year commercial warranty providing coverage against checking, splitting, splintering, rotting, structural damage from termites, and fungal decay of wood composite.

1.06 REFERENCE STANDARDS

- A. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Acceptable Manufacturer: Trex Fencing
- B. Other manufactures are acceptable subject to compliance with this specification or better.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.02 MATERIALS

- A. Wood composite: Reclaimed wood and plastic with integral coloring; free from toxic chemicals and preservatives:
 - 1. Characteristics:
 - a. Abrasion resistance: 0.01-inch wear per 1000 revolutions, tested to ASTM D 2394.
 - b. Hardness: 1124 pounds, tested to ASTM D 143.
 - c. Self-ignition temperature: 743 degrees F, tested to ASTM D 1929.
 - d. Flash ignition temperature: 698 degrees F, tested to ASTM D 1929.
 - e. Flame spread rating: 80, tested to ASTM E 84.
 - f. Water absorption, 24-hour immersion, tested to ASTM D 1037:
 - 1) Sanded surface: 4.3 percent.
 - 2) Unsanded surface: 1.7 percent.
 - g. Thermal expansion coefficient, 36-inch-long samples:
 - 1) Width: 35.2 x 10⁻⁶ to 42.7 x 10⁻⁶.
 - 2) Length: 16.1 x 10⁻⁶ to 19.2 x 10⁻⁶.
 - h. Fastener withdrawal, tested to ASTM D 1761:
 - 1) Screw: 558 pounds per inch.
 - i. Static coefficient of friction:
 - 1) Dry: 0.53 to 0.55, tested to ASTM D 2047.
 - 2) Dry: 0.59 to 0.70, tested to ASTM F 1679.
 - 3) Wet: 0.70 to 0.75, tested to ASTM F 1679.
 - j. Fungus resistance, white and brown rot: No decay, tested to ASTM D 1413.
 - k. Termite resistance: 9.6 rating, tested to AWPA E-1.
 - l. Specific gravity: 0.91 to 0.95, tested to ASTM D 2395.
 - m. Compression:
 - 1) Parallel: 1806 PSI ultimate, 550 PSI design, tested to ASTM D 198.
 - 2) Perpendicular: 1944 PSI ultimate, 625 PSI design, tested to ASTM D 143.
 - n. Tensile strength: 854 PSI ultimate, 250 PSI design, tested to ASTM D 198.
 - o. Shear strength: 561 PSI ultimate, 200 PSI design, tested to ASTM D 143.
 - p. Modulus of rupture: 1423 PSI ultimate, 250 PSI design, tested to ASTM D 4761.
 - q. Modulus of elasticity: 175,000 PSI ultimate, 100,000 PSI design, tested to ASTM D 4761.
 - r. Thermal conductivity: 1.57 BTU per inch per hour per square foot at 85 degrees F, tested to ASTM C 177.

2.03 COMPONENTS

- A. Fence System: Seclusions Privacy Fence System.
 - 1. Fence height:
 - a. Custom height as indicated on the Drawings.
 - 2. Components:
 - a. Fence posts. To be Galvanized post.

- b. Post caps:
 - 1) Flat.
- c. Top rail
- d. Aluminum bottom rail inserts.
- e. Bottom rail covers/Pickets, 67 inch.
- f. Bottom rail covers/Pickets, 91 inch.
- g. Fence brackets.
- 3. Surface texture: Smooth.
- 4. Color:
 - a. To be selected by Architect/Owner

2.04 ACCESSORIES

- A. Fasteners: 1-5/8 inch galvanized or corrosion-resistant coated steel. Nails are not allowed
- B. Concrete: Provide as Specified in Section 03 30 00 - Cast-in-Place Concrete; minimum 2500 PSI compressive strength at 28 days, with a 3-to-5-inch slump.
- C. Concrete: Provide concrete conforming to ASTM C 94; minimum 2500 PSI compressive strength at 28 days, with a 3-to-5-inch slump.
- D. Gate Hardware:
 - 1. Provide two Trex hinges per gate leaf minimum, and size to gate weight and conditions.
 - 2. Provide center gate stop and drop rod for double gates.
 - 3. Provide with latching mechanism.
 - 4. Provide with padlock provisions on the exterior of fence

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Cut and drill wood composite using carbide tipped blades.
- C. Space posts maximum 8 feet on center.
- D. Drill post holes into undisturbed or compacted soil; excavate deeper in soft or loose soils and for posts with heavy lateral loads.
- E. Drill posts to 12-inch diameter. Locate bottom of post 42 inches below grade or below frost line whichever is greater.
- F. Place top of concrete flush with finished grade.
- G. Screw fence brackets to posts with four 1-5/8-inch-long exterior screws.
- H. Cut top rails, pickets, bottom rail covers and aluminum bottom rails to lengths required.
- I. Slide bottom rail covers over aluminum bottom rail pieces.
- J. Position aluminum bottom rail on fence brackets with deeper side of rail channel facing downward.

- K. Cut end pickets to height to provide clearance under brackets and screw to posts.
- L. Insert pickets into bottom rail, interlocking adjacent pieces.
- M. Position top rail and screw attach to top brackets with 1-5/8-inch-long exterior screws.
- N. Use finish nails to secure pickets to rails if the pickets are not tightly interlocked.
- O. Place post caps over post tops and secure with construction adhesive or four finish nails.

3.04 CLEANING

- A. Clean wood composite to remove stains:
 - 1. Mold, mildew, and berry and leaf stains: Clean surfaces with conventional deck wash containing detergent or sodium hypochlorite.
 - 2. Rust and ground-in dirt: Clean surfaces with cleaner containing oxalic or phosphoric acid.
 - 3. Oil and grease: Clean surfaces with detergent containing degreasing agent.

3.05 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

Appendix

- A. Hazardous Building Materials Survey Report, Atlas Project ID: 204BS07143 (42 pages)



HAZARDOUS BUILDING MATERIALS SURVEY REPORT

PREPARED FOR:

Samuels Group
317 6th Avenue
Des Moines, IA 50309

PROJECT LOCATION:

Girl's Dorm Upgrades Project #9356
Iowa School for the Deaf
Council Bluffs, Iowa

Project Date: May 28-29 and June 28, 2024

Report Date: July 23, 2024

Atlas Project ID: 204BS07143

PREPARED BY:

Atlas Technical Consultants
11117 Mockingbird Drive
Omaha, NE 68137



July 23, 2024

Mr. Jerry Dehnke
Samuels Group
317 6th Avenue
Des Moines, IA 50309

Re: Hazardous Building Materials Survey Report
Girl's Dorm Upgrades Project #9356
Iowa School for the Deaf
Council Bluffs, Iowa
Atlas Project Number: 204BS07143

Atlas is pleased to submit the attached Hazardous Building Materials Survey Report for the above-referenced site. This report includes procedures, methodologies and analytical laboratory results.

Atlas appreciates the opportunity to perform these services for the IDAS and the Samuels Group, and we look forward to working with you in the future. If you need any assistance with the implementation of the recommendations contained in this report, please feel free to give us a call at (402) 670-3842 and we will respond promptly to your needs.

Sincerely,

ATLAS TECHNICAL CONSULTANTS, LLC

Prepared By:

A handwritten signature in blue ink that reads "Joe McCaslin".

Joe McCaslin
Environmental Technician

Reviewed By:

A handwritten signature in black ink that reads "Steve Hudson".

Steve Hudson, MS, CIH, CIEC
Sr. Project Manager

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H A Z A R D O U S B U I L D I N G M A T E R I A L S S U R V E Y R E P O R T

Girls Dorm Upgrades Project
Iowa School for the Deaf
Council Bluffs, Iowa
Atlas Project Number: 204BS07143

1.0 SCOPE OF SERVICES

The purpose of this project was to perform a survey for hazardous building materials that may be impacted by planned upgrades project activities at the above-referenced property.

Atlas provided a representative hazardous materials survey in accordance with the referenced agreement and as outlined below:

1. Review any existing hazardous building material survey reports relating to the site, if available.
2. Identify suspect asbestos-containing materials (ACM), surface coatings potentially containing lead paint, and hazardous building materials within the planned upgrades project work areas.
3. Collect and analyze bulk samples of suspect asbestos containing materials and collect paint chip samples from representative surface coatings potentially containing lead-based or lead-containing paint.
4. Provide laboratory analysis of collected samples.
5. Provide a report of findings with copies and interpretation of analytical results and identifying the locations of asbestos-containing materials, lead paint, and hazardous building materials.

2.0 GENERAL SITE CONDITIONS

The survey was conducted at the Girl's Dorm Building located at the Iowa School for the Deaf in Council Bluffs, Iowa. The survey area was limited to the areas to be disturbed as part of planned upgrades project activities.

3.0 ASBESTOS SURVEY

On May 28-29 and June 28, 2024, the Girl's Dorm Building was inspected for asbestos-containing building materials by inspector Steve Hudson of Atlas. Mr. Hudson has completed the requisite training for asbestos accreditation as inspectors at a state approved training provider under TSCA Title II. Mr. Hudson's State of Iowa Inspector number is 24-11325.

The planned renovation work areas were visually inspected for the presence of suspect asbestos-containing materials (ACM). Materials that were hidden, not accessible, or when sampled would damage the integrity of the structure, were not sampled as part of this survey. Materials visibly identified as non-asbestos (fibrous glass, foam rubber, wood, etc.) were not sampled. The asbestos survey consisted of three basic steps: **1)** a visual inspection of the proposed work areas; **2)** a determination of homogeneous areas with suspect surfacing, thermal system insulation, and miscellaneous materials; and **3)** sampling accessible, friable and non-friable, suspect materials.

3.1 Regulation Review

The U.S. EPA qualifies asbestos-containing materials (ACM) as materials with an asbestos content greater than 1%. The following definitions are taken from Section 61.141 of Subpart M, Part 61 of Title 40: Protection of Environment of the Code of Federal Regulations (CFR).

- “Category I non-friable asbestos-containing material (ACM)” is defined as asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1% asbestos as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy (PLM).
- “Category II non-friable ACM” is defined as any material, excluding Category I non-friable ACM, containing more than 1% asbestos as determined using the methods specified in appendix E, subpart E, 40 CFR part 763, section 1, PLM that, when dry, **cannot** be crumbled, pulverized, or reduced to powder by hand pressure.
- “Friable asbestos material” is defined as any material containing more than 1% asbestos as determined using the methods specified in appendix E, subpart E, 40 CFR part 763, section 1, PLM that when dry, **can** be crumbled, pulverized, or reduced to powder by hand pressure. If the asbestos content is less than 10% as determined by a method other than point counting by PLM, verify the asbestos content by point counting using PLM.

3.2 Homogeneous Areas

Prior to sampling, homogeneous areas were identified in order to facilitate a sampling strategy. A homogeneous sampling area can be described as one or more areas with suspect material similar in appearance and texture that have the same installation date and function. The actual number of samples collected from each homogeneous sampling area may vary, dependent upon material type and the

professional judgment of the inspector.

3.3 Sampling Strategy

The sampling strategy incorporated AHERA requirements, quantities of suspect material, and the inspector's judgment to aid in the identification of suspect asbestos-containing materials. If the analytical results indicated that all the samples collected per homogeneous area did not contain asbestos, then the homogeneous area (material) was considered non-asbestos-containing. However, if the analytical results of one or more of the samples collected per homogeneous area indicated that asbestos was present in quantities greater than one percent asbestos (as defined by EPA), all of the homogeneous area (material) was treated as an asbestos-containing material regardless of any other analytical results. Materials which were visually determined to be non-asbestos (i.e. fibrous glass, foam rubber, etc.) by the accredited inspector were not required to be sampled. Actual collection of a bulk asbestos sample involves physically removing approximately one square inch (1 in²) of material and placing it in an airtight sample container. Sample containers were marked with a unique identification number, which was documented in the field notes.

3.4 Suspect Asbestos-Containing Materials

The following table contains a list of the sixty-two (62) identified suspect asbestos containing materials sampled:

TABLE 1: SUSPECT ASBESTOS MATERIALS			
MATERIAL	WING	LOCATION	SAMPLE NUMBER
Ceiling Texture – White Swirl (White)	61	3 rd Floor, Room 306 – Laundry	1
Ceiling Texture – White Swirl (White)	61	3 rd Floor, Room 311	2
Ceiling Texture – White Swirl (White)	61	2 nd Floor, Room 215	3
Carpet Mastic (Black/Brown)	61	Room 303	4
Carpet Mastic (Black/Brown)	61	Room 316	5
4" Grey Base Cove (Grey)	61	Closet 305	6 – Base Cove
Brown Mastic (Brown)	61	Closet 305	6 - Mastic
Plaster (White)	61	Flex Room 147	7 - Plaster
Plaster (Tan/White)	61	Flex Room 147	7 – Skim Coat
Plaster (White)	61	Room 215	8 - Plaster
Plaster (Tan/White)	61	Room 215	8 – Skim Coat
Plaster (White)	61	Room 215	9

TABLE 1: SUSPECT ASBESTOS MATERIALS			
MATERIAL	WING	LOCATION	SAMPLE NUMBER
Drywall (Brown/White)	61	Room 215	10
Drywall (Brown/White)	61	Room 213	11
Drywall (Brown/White)	61	Room 104	12
Joint Compound (White)	61	Room 215	13
Joint Compound (White)	61	Room 213	14
Joint Compound (White)	61	Room 104	15
Caulking Around Interior of Mapes Board (Grey)	61	Room 302	16
Floor Mastic (Black/Brown)	61	Room 215	17
Base Cove (Grey)	61	Kitchen 208	18 – Base Cove
Mastic (Brown)	61	Kitchen 208	18 – Mastic
12X12 Floor Tile (Grey/Blue Streaks)	61	Kitchen 208	19 – Floor Tile
Mastic (Brown/Black)	61	Kitchen 208	19 - Mastic
2X4 Ceiling Tile (Grey/White)	61	Room 114	20
Epoxy Flooring (Tan)	61	Hallway by Room 108	21
Steam Pipe Mudded Fitting (Grey)	61	Room 108	22
Girl's Hot Water Mudded Fitting (Tan)	61	Room 108	23
Steam Tank Insulation (Grey/Green)	61	Room 108	24
Hot Water Pipe Mudded Fitting (Grey)	61	Room 108	25
Recirc Pipe Mudded Fitting (Grey)	61	Room 108	26
Window Calking (Black)	61	Room 140	27
Ceiling Texture – White Swirl (White)	71	Room 328	28
Ceiling Texture – White Swirl (White)	71	Room 146	29
Ceiling Texture – White Swirl (White)	71	Room 225	30
Carpet Mastic (Yellow)	71	Room 328	31
4" Base Cove (Grey)	71	Room 328	32 – Base Cove
Base Cove Mastic (Brown)	71	Room 328	32 - Mastic
2x4 Ceiling Tile (Grey/White)	71	Room 146	33
Ceiling Adhesive Pucks (Brown)	61	C110 - Lobby	34
Ceiling Adhesive Pucks (Brown)	61	C110 - Lobby	35 – Mastic
Concrete (Grey)	61	C110 - Lobby	35 - Concrete

TABLE 1: SUSPECT ASBESTOS MATERIALS			
MATERIAL	WING	LOCATION	SAMPLE NUMBER
Vibration Damper on Duct (Brown/Grey)	61	Room 123A	36
Leveling Compound (Grey)	71	Room 139	37
Carpet Mastic (Yellow)	71	Room 139	38
2x2 Ceiling Tile (Grey/White)	71	Corridor 066	39
Drywall (Brown/White)	71	Corridor 066	40
Joint Compound (Tan)	71	Corridor 066	41
Interior Window Glazing (Grey)	71	Room 125	42
Texture Swirl (White)	71	Room 129	43
12x12 Floor Tile with Streaks (Beige)	71	Room 122	44 – Floor Tile
Mastic (Gold)	71	Room 122	44 - Mastic
4" Base Cove (Grey)	71	Room 122	45 – Base Cove
Mastic (White)	71	Room 122	45 – Mastic
Joint Compound (Tan)	71	Room 122	45- Joint Compound
Interior Window Glazing (White)	71	Room 228	46
2x2 Ceiling Tile White Pinhole (Grey/White)	71	Room 248	47
Drywall (Brown/White)	71	Room 326	48
Joint Compound (White)	71	Room 326	49
Interior Window Glazing White Powder (White)	71	Room 054	50
Caulking Around Window Opening (Tan)	61	Exterior - West Side	51
Caulking Around Window (Grey)	71	Exterior - South Side	52
Caulking Around Lintel (Grey)	71	Exterior - South Side	53
Brickwork (Tan)	71	Exterior - South Side	54
Brick Grout (Grey)	61	Exterior - West Side	55
Brick Grout (Grey/White)	71	Exterior - South Side	56
Caulking Around Mapes Board (Black)	61	Exterior - East Side	57
Expansion Joint (Grey)	71	Exterior - North Side	58
Caulking Around Window (Grey)	61	Exterior - South Side	59

TABLE 1: SUSPECT ASBESTOS MATERIALS			
MATERIAL	WING	LOCATION	SAMPLE NUMBER
Floor Mastic (Black/Brown) under Carpet	61	Room 215	60
Floor Mastic (Black/Brown) under Carpet	61	Room 218	61
Floor Mastic (Black/Brown) under Carpet	61	Room 213	62

The following table is a summary of the materials determined to contain asbestos:

TABLE 2: ASBESTOS-CONTAINING MATERIALS				
MATERIAL	LOCATION	SAMPLE #	APPROX. QUANTITY	ASBESTOS CONTENT
Floor Mastic (Black/Brown) under Carpet	Wing 61 – Room215	17	Old Mastic Remnants on Floor	<1% Chrysotile
Steam Pipe Mudded Fittings (Grey)	Wing 61 – 1 st Floor - Room 108	22	40	7% Chrysotile
Steam Tank Insulation (Grey/Green)	Wing 61 - Room 108	24	160 SF	10% Amosite 65% Chrysotile
Hot Water Pipe Mudded Fittings (Gray)	Wing 61 - Room 108	25	24	8% Chrysotile
Recirculating Pipe Mudded Fittings (Gray)	Wing 61 - Room 108	26	10	8% Chrysotile
Joint Compound	Wing 71 – Room 066	41	Floors & Ceilings Throughout Wing 71	<1% Chrysotile
Joint Compound	Wing 71 – Room 122	45		<1% Chrysotile
Joint Compound	Wing 71 – Room 326	49		2% Chrysotile
Interior Window Glazing (Gray)	Wing 71 – Room 125	42	Non-Operable Windows – N & S sides Only	2% Chrysotile
Interior Window Glazing White Power (White)	Wing 71 – Room 228	46		2% Chrysotile
SF = Square Feet, LF = Linear Feet MF = Mechanical Fittings				

3.5 Laboratory Analytical Results

Bulk samples were analyzed by EMSL Analytical, Inc. located at 200 Route 130 North, Cinnaminson, NJ. Polarized Light Microscope analysis, utilizing dispersion staining techniques (ref.: EPA Method 600/M4-82-020), was performed to determine the asbestos content of the bulk samples collected at the site. This laboratory is currently a proficient participant in the American Industrial Hygiene Association (AIHA) Bulk Asbestos Proficiency Analytical Testing Program; a quality assurance program for polarized light microscopy analysis. Any material that contains greater than one percent asbestos is considered an ACM and must be handled according to Occupational Safety and Health Administration (OSHA), EPA, and all applicable state and local regulations.

Laboratory test results are provided in Appendix A.

4.0 LEAD PAINT SURVEY

On May 28-29 and June 28, 2024, the Girl's Dorm Building was inspected for lead paint by Steve Hudson of Atlas. The purpose of the survey was to identify locations and concentrations of lead in paints and coatings on interior and exterior building components that may be disturbed as part of planned upgrades project activities.

4.1 Inspection

The lead survey was performed in general accordance with the U.S. Housing and Urban Development Chapter 7 of the *Guidelines for the evaluation and Control of Lead-Based Paint Hazards in Housing* (1997 Revision). Survey criteria included the inspection and sampling of the representative painted surfaces on the interior of the building.

Regulatory limits from the Housing and Urban Development (HUD) and the Environmental Protection Agency (EPA) establishes that lead-based paint (LBP) by definition is paint that contains more than 0.5% of lead in paint. OSHA's "Lead in Construction Standard" (29 CFR 1926.1101) addresses any concentration of lead in paint ("lead-containing paint").

Prior to demolition or renovation activities, all contractors involved should be notified regarding the presence of painted components under the guidelines of the OSHA Lead in Construction standard 29 CFR 1926.62. Care should be exercised in acknowledging that the OSHA 29 CFR 1926.62 has no LBP threshold definition and is concerned with exposures generated by LBP disturbances, which may include materials containing less than 0.5% lead by weight. The OSHA regulations are based strictly on airborne lead concentrations; therefore, the measured lead concentration of the paint and the method of paint disturbance will both factor into the potential airborne hazard.

OSHA requires the contractor to inform its employees of potential lead hazards, based upon the work being performed. The purpose of OSHA's Lead Construction Standard is to reduce the exposure to lead for all construction workers. It is for this reason that Atlas recommends contractors be informed of the presence of lead. OSHA's standard includes an 8-hour time weighted average (TWA) of 50 micrograms of lead per cubic meter of air (mg/m^3) and an action level (regardless of respirator use) of $30 \text{ mg}/\text{m}^3$.

Prior to disposal of debris that contains materials that have been found to contain lead, conduct a Toxicity Characteristic Leaching Procedures (TCLP) on representative solid wastes. This will determine if the debris requires a hazardous waste disposal site. A TCLP was not collected as part of this current inspection.

4.2 Lead Paint Testing

A total of six (6) surface coatings were tested to determine the concentration of lead. The sampling generally involved the collection of the paint on the surface down to the substrate over an area of approximately 2 to 3 square inches. A summary of the tested paints is provided in the table below. In order for a surface coating to be considered a lead-based paint, the paint must contain lead in concentrations greater than 0.5% by weight. A detectable concentration of lead in the surface coating below 0.5% by weight is considered a lead-containing paint.

The full copy of the lead analytical results is included in Appendix B.

Table 3. Lead Paint Test Results

Sample No.	Paint Color	Substrate	Surface	Sample Location	Results (% wt)
P-1	White	Drywall	Wall	3 rd Floor – Rm 147 South Wall below Window	<0.012%
P-2	White	Plaster	Wall	3 rd Floor – Rm 147 South Wall	<0.008%
P-3	White	Concrete	Wall	3 rd Floor – Rm 313 Wall Above Window	0.064%
P-4	White / Yellow	Metal	Radiator	3 rd Floor – Rm 302 Radiator	<0.008%
P-5	Tan / Green	Metal	Duct work	Room 119 Painted Duct	0.008%
P-6	White	Concrete Block	Wall	Rm 228 By Window	0.024%

- Lead-Based Paint (>0.5%) was not identified in any of the sampled coatings.
- Lead Containing Paint (<0.5%) was identified in 3 of the 6 sampled coatings.

This evaluation report can help the Owner develop a plan for renovating the building by having concentrations of lead in the paint identified. It is our understanding that the information in this report will be provided to the contractors so that appropriate precautions can be made to minimize worker exposure to lead. If surface coatings with lead containing paint are handled improperly, exposure could occur to workers and future occupants of the facility.

5.0 HAZARDOUS MATERIALS ASSESSMENT

Atlas completed a visual inspection of rooms / areas throughout the intended work areas to identify hazardous wastes or universal wastes that may be impacted by planned renovation activities. The survey included a visual inspection of: light fixtures and other equipment for the presence of Polychlorinated Biphenyls (PCBs); light bulbs, thermostats, switches, and other equipment for the presence of mercury; refrigerants, batteries, and devices with potential radioactive materials.

TABLE 4: HAZARDOUS BUILDING MATERIALS		
Category	Material	Estimated Quantity
Poly-Chlorinated Biphenyl (PCBs)	Transformers	N/A
	Transistors	N/A
	Light Ballasts	N/A
Mercury	Thermostats	N/A
	Switches/Relays	N/A
	Fluorescent Light Tubes	352
	High Intensity Discharge lights	N/A
	Thermometers/ Manometers	N/A
Batteries	Smoke Detectors	137
	Emergency Lighting Systems	113
	Exit Signs	29
	Flashing Fire Alarms	98
Chlorofluorocarbons (CFCs) or Hydro Chlorofluorocarbons (HCFCs)	Refrigerators/Freezers/Chillers	N/A
Low Level Radioactive Sources (LLR)	Smoke/Fire Alarms	76

Hazardous materials or universal wastes identified in Table 4 shall be removed as part of the renovation contractor's scope of work and disposed of according to US EPA Toxic Substances Control Act (TSCA) and the State of Iowa regulations.

6.0 CONCLUSIONS

The following conclusions are summarized as follows:

- Asbestos was identified in the following materials that may be impacted by planned upgrade project activities:
 - Pipe fittings in Wing 61 – Mechanical Room 108
 - Tank insulation in Wing 61 – Mechanical Room 108
 - Interior window glazing in Wing 71 – Non-operable windows on the north and south sides
 - Joint Compound on walls / ceilings throughout Wing 71
 - Old brown/black floor mastic remnants, under carpet, potentially throughout 2nd and 3rd floors of Wing 61
- Lead-based paint was not identified in the suspect surface coatings tested.
- Lead containing paint was identified in 3 of the 6 surface coatings tested.

7.0 ASSUMPTIONS AND LIMITATIONS

The results, findings, conclusions, and recommendations expressed in this report are based solely on conditions noted during the May 28-29 and June 28, 2024, Atlas hazardous building materials survey of the Girls Dorm Building located at the Iowa School for the Deaf in Council Bluffs, Iowa. The survey was limited to surfaces to be impacted by planned upgrades project activities.

Atlas did not perform destructive sampling -- it was not within Atlas's scope of work to remove surface materials to investigate portions of the structure or materials that may lay beneath the surface -- thus, any materials that could not be visually identified on the surface were not inspected and would not be noted in this report. Atlas's selection of sample locations and frequency of sampling was based on the inspector's assumption that like materials in the same area are homogeneous in content.

The report is designed to aid the building owner, architect, construction manager, general contractor, and potential abatement contractor in locating hazardous building materials. Under no circumstances is the report to be utilized as a bidding document or as a project specification document since it does not have all the components required to serve as a Project Design document or an Abatement Work plan.

Our professional services have been performed, our findings obtained, and our conclusions and recommendations prepared in accordance with customary principles and practices in the fields of environmental science and engineering. This statement is in lieu of other statements either expressed or implied. This report does



not warrant against future operations or conditions, nor does it warrant against operations or conditions present of a type or at a location not investigated.

This report is intended for the sole use of the IDAS and Samuels Group. The scope of services performed in execution of this evaluation may not be appropriate to satisfy the needs of other users and use or re-use of this document or the findings, conclusions, or recommendations is at the risk of said user.

APPENDIX A
ASBESTOS TEST RESULTS



EMSL Analytical, Inc.

200 Route 130 North Cinnaminson, NJ 08077

Tel/Fax: (800) 220-3675 / (856) 786-5974

<http://www.EMSL.com> / cinnaslab@EMSL.com

EMSL Order: 042411146

Customer ID: ATC55

Customer PO:

Project ID:

Attention: Steve Hudson
Atlas Technical
11117 Mockingbird Drive
Omaha, NE 68137

Phone: (402) 697-9747

Fax: (402) 597-8532

Received Date: 06/04/2024 12:00 AM

Analysis Date: 06/04/2024 - 06/05/2024

Collected Date:

Project: 204BS07143 / IOWA DAS / Girls Dorm Upgrade Project #9356 / IA School for the Deaf Girls Dorm

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
1 042411146-0001	Room 306 - Laundry - Ceiling Texture - White Swirl	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
2 042411146-0002	Room 311 - Ceiling Texture - White Swirl	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
3 042411146-0003	Room 215 - Ceiling Texture - White Swirl	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
4 042411146-0004	Room 303 - Carpet Mastic (Black/Brown)	Brown/Black Non-Fibrous Heterogeneous		100% Non-fibrous (Other)	None Detected
5 042411146-0005	Room 316 - Carpet Mastic (Black/Brown)	Brown/Black Non-Fibrous Heterogeneous		100% Non-fibrous (Other)	None Detected
6-Base Cove 042411146-0006	Closet 305 - 4" Grey Base Cove	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
6-Mastic 042411146-0006A	Closet 305 - Brown Mastic	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
7-Plaster 042411146-0007	Flex Room 147 - Plaster - Walls	White Non-Fibrous Homogeneous	2% Hair	98% Non-fibrous (Other)	None Detected
7-Skim Coat 042411146-0007A	Flex Room 147 - Plaster - Walls	Tan/White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
8-Plaster 042411146-0008	Room 215 - Plaster - Walls	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
8-Skim Coat 042411146-0008A	Room 215 - Plaster - Walls	Tan/White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
9 042411146-0009	Room 215 - Plaster - Walls	White Non-Fibrous Homogeneous		5% Perlite 95% Non-fibrous (Other)	None Detected
10 042411146-0010	Room 215 - Drywall	Brown/White Fibrous Homogeneous	15% Cellulose 3% Glass	82% Non-fibrous (Other)	None Detected
11 042411146-0011	Room 213 - Drywall	Brown/White Fibrous Homogeneous	15% Cellulose 3% Glass	82% Non-fibrous (Other)	None Detected
12 042411146-0012	Room 104 - Drywall	Brown/White Fibrous Homogeneous	12% Cellulose 3% Glass	85% Non-fibrous (Other)	None Detected
13 042411146-0013	Room 215 - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Initial report from: 06/05/2024 12:13:51



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EMSL Order: 042411146

Customer ID: ATC55

Customer PO:

Project ID:

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
14 042411146-0014	Room 213 - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
15 042411146-0015	Room 104 - Joint Compound	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
16 042411146-0016	Room 302 - Caulking Around Interior of Mapes Board	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
17 042411146-0017	Room 215 - Carpet Mastic (Black/Brown)	Brown/Black Non-Fibrous Heterogeneous		100% Non-fibrous (Other)	<1% Chrysotile
18-Base Cove 042411146-0018	Kitchen - 208 - 4" Grey Base Cove	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
18-Mastic 042411146-0018A	Kitchen - 208 - Brown Mastic	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
19-Floor Tile 042411146-0019	Kitchen - 208 - 12"x12" Floor Tile (Blue/Grey Streaks)	Gray/Blue Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
19-Mastic 042411146-0019A	Kitchen - 208 - Brown/Black Mastic	Brown/Black Non-Fibrous Heterogeneous		100% Non-fibrous (Other)	None Detected
20 042411146-0020	Room 114 - 2'x4' Ceiling Tile - White Pinhole	Gray/White Fibrous Homogeneous	40% Cellulose 40% Min. Wool	20% Non-fibrous (Other)	None Detected
21 042411146-0021	Hall by Room 108 - Epoxy Flooring	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
22 042411146-0022	Room 108 - Steam Pipe-Mudded Fitting	Gray Fibrous Homogeneous	45% Min. Wool	48% Non-fibrous (Other)	7% Chrysotile
23 042411146-0023	Room 108 - Girls Hot Water - Mudded Fitting	Tan Fibrous Homogeneous	60% Cellulose 3% Glass	37% Non-fibrous (Other)	None Detected
Result includes a small amount of inseparable attached material					
24 042411146-0024	Room 108 - Steam Tank Insulation (Green)	Gray/Green Fibrous Homogeneous		25% Non-fibrous (Other)	10% Amosite 65% Chrysotile
25 042411146-0025	Room 108 - Hot Water Pipe - Mudded Fitting	Gray Fibrous Homogeneous	45% Min. Wool	47% Non-fibrous (Other)	8% Chrysotile
26 042411146-0026	Room 108 - Recine Pipe - Mudded Fitting	Gray Fibrous Homogeneous	45% Min. Wool	47% Non-fibrous (Other)	8% Chrysotile
27 042411146-0027	Room 140 - Window Caulk (Gray) Interior	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
28 042411146-0028	Room 328 - Ceiling Texture - White Swirl	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
29 042411146-0029	Room 146 - Ceiling Texture - White Swirl	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected



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EMSL Order: 042411146

Customer ID: ATC55

Customer PO:

Project ID:

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
30 042411146-0030	Room 225 - Ceiling Texture - White Swirl	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
31 042411146-0031	Room 328 - Carpet Mastic - Yellow	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
32-Base Cove 042411146-0032	Room 328 - 4" Base Cove (Gray)	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
32-Mastic 042411146-0032A	Room 328 - Brown Mastic	Brown Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
33 042411146-0033	Room 146 - 2'x4' Ceiling Tile - White Pinhole/Fissure	Gray/White Fibrous Homogeneous	50% Cellulose 30% Min. Wool	20% Non-fibrous (Other)	None Detected
34 042411146-0034	C110 - Lobby - Ceiling Adhesive Pucks Brown	Brown Non-Fibrous Homogeneous	2% Fibrous (Other)	98% Non-fibrous (Other)	None Detected
35-Mastic 042411146-0035	C110 - Lobby - Ceiling Adhesive Pucks Brown	Brown Non-Fibrous Homogeneous	5% Fibrous (Other)	95% Non-fibrous (Other)	None Detected
35-Concrete 042411146-0035A	C110 - Lobby - Concrete	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
36 042411146-0036	123A - Vibration Damper on Duct	Brown/Gray Fibrous Homogeneous	35% Cellulose	65% Non-fibrous (Other)	None Detected
37 042411146-0037	139 - Leveling Compound (Gray)	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
38 042411146-0038	139 - Carpet Mastic - Yellow	Yellow Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
39 042411146-0039	Corridor 066 - 2'x2' Ceiling Tile with Pinhole/Fissure	Gray/White Fibrous Homogeneous	60% Cellulose	40% Non-fibrous (Other)	None Detected
40 042411146-0040	Corridor 066 - Drywall	Brown/White Fibrous Homogeneous	15% Cellulose 5% Glass	80% Non-fibrous (Other)	None Detected
41 042411146-0041	Corridor 066 - Joint Compound	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	<1% Chrysotile
42 042411146-0042	Room 125 - Window Glazing (Interior)	Gray Non-Fibrous Homogeneous		98% Non-fibrous (Other)	2% Chrysotile
43 042411146-0043	Room 129 - Texture - Swirl	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
44-Floor Tile 042411146-0044	Room 122 - 12"x12" Floor Tile Cream w/Streaks)	Beige Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
44-Mastic 042411146-0044A	Room 122 - Gold Mastic	Gold Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
45-Base Cove 042411146-0045	Room 122 - 4" Gray Base Cove	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected

Initial report from: 06/05/2024 12:13:51



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EMSL Order: 042411146

Customer ID: ATC55

Customer PO:

Project ID:

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
45-Mastic 042411146-0045A	Room 122 - White Mastic	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
45-Joint Compound 042411146-0045B	Room 122 - Joint Compound	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	<1% Chrysotile
46 042411146-0046	Room 228 - Window Glazing Interior - White Powder	White Non-Fibrous Homogeneous		98% Non-fibrous (Other)	2% Chrysotile
47 042411146-0047	Room 248 - 2'x2' Ceiling Tile - White Pinhole	Gray/White Fibrous Homogeneous	60% Min. Wool	40% Non-fibrous (Other)	None Detected
48 042411146-0048	Room 326 - Drywall	Brown/White Fibrous Homogeneous	15% Cellulose 5% Glass	80% Non-fibrous (Other)	None Detected
49 042411146-0049	Room 326 - Joint Compound	White Non-Fibrous Homogeneous		98% Non-fibrous (Other)	2% Chrysotile
50 042411146-0050	Room 054 - Window Glazing Interior White Powder	White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
51 042411146-0051	'61 Wing - West Side - Caulk Around Window Opening	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
52 042411146-0052	71' Wing - South Side - Caulking around Window - Grey	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
53 042411146-0053	71' Wing - South Side - Caulking Around Lintel - White	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
54 042411146-0054	71' Wing - South Side - Brickwork	Tan Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
55 042411146-0055	61' Wing - West Side - Brick Grout	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
56 042411146-0056	71' Wing - South Side - Brick Grout	Gray/White Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
57 042411146-0057	61' Wing - East Side - Caulking Black Around Mapis Board	Black Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
58 042411146-0058	71' Wing - North Side - Expansion Joint	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected
59 042411146-0059	61' Wing - South Side - Caulking Around Window -S. Side	Gray Non-Fibrous Homogeneous		100% Non-fibrous (Other)	None Detected



EMSL Analytical, Inc.

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EMSL Order: 042413417

Customer ID: ATC55

Customer PO:

Project ID:

Attention: Steve Hudson
Atlas Technical
11117 Mockingbird Drive
Omaha, NE 68137

Phone: (402) 697-9747

Fax: (402) 597-8532

Received Date: 06/29/2024 10:15 AM

Analysis Date: 07/01/2024

Collected Date: 06/28/2024

Project: 204BS07143

Test Report: Asbestos Analysis of Bulk Materials via AHERA Method 40CFR 763 Subpart E Appendix E supplemented with EPA 600/R-93/116 using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
60 042413417-0001	Room 215, 2nd Floor - Floor Mastic (Black/Brown), under Carpet	Brown/Black Non-Fibrous Heterogeneous		100% Non-fibrous (Other)	None Detected
61 042413417-0002	Room 218, 2nd Floor - Floor Mastic (Black/Brown), under Carpet	Brown/Black Non-Fibrous Heterogeneous		100% Non-fibrous (Other)	None Detected
62 042413417-0003	Room 213, 2nd Floor - Floor Mastic (Black/Brown)	Brown/Black Non-Fibrous Heterogeneous		100% Non-fibrous (Other)	None Detected

Analyst(s)

Brett Teixeira (2)

Brett Polumbo (1)

Samantha Rundstrom, Laboratory Manager
or Other Approved Signatory

EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above, and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. Samples are within quality control criteria and met method specifications unless otherwise noted. The above analyses were performed in general compliance with Appendix E to Subpart E of 40 CFR (previously EPA 600/M4-82-020 "Interim Method") but augmented with procedures outlined in the 1993 ("final") version of the method. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-friable organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Unless requested by the client, building materials manufactured with multiple layers (i.e. linoleum, wallboard, etc.) are reported as a single sample. Estimation of uncertainty is available on request.

Samples analyzed by EMSL Analytical, Inc. Cinnaminson, NJ NVLAP Lab Code 101048-0, AIHA LAP, LLC-IHLAP Lab 100194, PA ID# 68-00367, LA #04127

Initial report from: 07/01/2024 15:27:05

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Asbestos Chain of Custody (Air, Bulk, Soil)

EMSL Order Number / Lab Use Only

EMSL Analytical, Inc.
6340 Castleplace Dr.Indianapolis, IN 46250
PHONE: (317) 803-2997
EMAIL: indianapolislabs@emsl.com

042411146

If Bill-To is the same as Report-To leave this section blank. Third-party billing requires written authorization.

Customer Information	Customer ID:	Billing ID:
	Company Name: Atlas Technical Consultants, LLC	Company Name: Atlas Technical Consultants, LLC
	Contact Name: Steve Hudson	Billing Contact: Steve Hudson
	Street Address: 11117 Mockingbird Drive	Street Address: 11117 Mockingbird Drive
	City, State, Zip: Omaha NE 68137 Country: US	City, State, Zip: Omaha NE 68137 Country: US
	Phone: 14026703842	Phone: 14026703842
Email(s) for Report: steve.hudson@oneatlas.com		Email(s) for Invoice:

Project Information	
Project Name/No: 2040507143	Purchase Order:
EMSL LIMS Project ID: (If applicable, EMSL will provide)	US State where samples collected: IA
State of Connecticut (CT) must select project location:	☐ Commercial (Taxable) ☐ Residential (Non-Taxable)
Sampled By Name:	Sampled By Signature:
No. of Samples In Shipment: 59	

Turn-Around-Time (TAT)	
☐ 3 Hour ☐ 4-4.5 Hour ☐ 6 Hour ☒ 24 Hour ☐ 32 Hour ☐ 48 Hour ☐ 72 Hour ☐ 96 Hour ☐ 1 Week ☐ 2 Week	
TEM Air 3-6 Hour, please call ahead to schedule. 32 Hour TAT available for select tests only; samples must be submitted by 11:30 am.	

Test Selection		
PCM Air ☐ NIOSH 7400 ☐ NIOSH 7400 w/ 8hr. TWA ☒ PLM - Bulk (reporting limit) ☒ PLM EPA 600/R-93/116 (<1%) ☐ PLM EPA NOB (<1%) ☐ POINT COUNT ☐ 400 (<0.25%) ☐ 1,000 (<0.1%) POINT COUNT w/ GRAVIMETRIC ☐ 400 (<0.25%) ☐ 1,000 (<0.1%) ☐ NIOSH 9002 (<1%) ☐ NYS 198.1 (Friable - NY) ☐ NYS 198.6 NOB (Non-Friable - NY) ☐ NYS 198.8 (Vermiculite SM-V)	TEM - Air ☐ AHERA 40 CFR, Part 763 ☐ NIOSH 7402 ☐ EPA Level II ☐ ISO 10312* TEM - Bulk ☐ TEM EPA NOB ☐ NYS NOB 198.4 (Non-Friable-NY) ☐ TEM EPA 600/R-93/116 w Milling Prep (0.1%) Other Test (please specify)	TEM - Settled Dust ☐ Microvac - ASTM D5755 ☐ Wipe - ASTM D6480 ☐ Qualitative via Filtration Prep ☐ Qualitative via Drop Mount Prep Soil - Rock - Vermiculite (reporting limit) ☐ PLM EPA 600/R-93/116 with milling prep (<0.25%) ☐ PLM EPA 600/R-93/116 with milling prep (<0.1%) ☐ TEM EPA 600/R-93/116 with milling prep (<0.1%) ☐ TEM Qualitative via Filtration Prep ☐ TEM Qualitative via Drop Mount Prep

*Please call with your project-specific requirements.

☐ Positive Stop - Clearly Identified Homogeneous Areas (HA)		Filter Pore Size (Air Samples) ☐ 0.8um ☐ 0.45um	
Sample Number	Sample Location / Description	Volume, Area or Homogeneous Area	Date / Time Sampled (Air Monitoring Only)
	SEE ATTACHED		

Special Instructions and/or Regulatory Requirements (Sample Specifications, Processing Methods, Limits of Detection, etc.)

Method of Shipment:		Sample Condition Upon Receipt:	
Relinquished by: [Signature]	Date/Time: 5/30/04	Received by: [Signature]	Date/Time: 6/4/04
Relinquished by:	Date/Time:	Received by:	Date/Time:

Controlled Document - COC-05 Asbestos R15 4/23/2021

☒ AGREE TO ELECTRONIC SIGNATURE (By checking, I consent to signing this Chain of Custody document by electronic signature.)

EMSL Analytical, Inc.'s Laboratory Terms and Conditions are incorporated into this Chain of Custody by reference in their entirety. Submission of samples to EMSL Analytical, Inc. constitutes acceptance and acknowledgment of all terms and conditions by Customer.

ASBESTOS BULK SAMPLE FORM

Page ____ of ____

11117 Mockingbird Drive
Omaha, NE 68137Phone (402) 697-9747
Fax (402) 597-8532

Project Information

Client: IOWA DAS	Project Description: Girls Dorm Upgrade Project #9356	Project Manager: Steve Hudson Inspector: Steve Hudson
Date: May 29, 2024	Site Location: IA School for the Deaf Girls Dorm	ATLAS PROJECT NUMBER: 204BS07143

Sample #	Material Description	Floor	HA	Sample Location	Quantity
1	CEILING TEXTURE - white swirl	3		Room 306 - LAUNDRY	
2	L	3		Room 311	
3		2		Room 215	
4		3		Room 303	
5	L	3		Room 316	
6	4" GREY BASE COAT & BROWN MASTIC	3		Closet 305	
7	plaster walls	3		Flex Room 147	
8	L	2		Room 215	
9		2		Room 215	
10	DRYWALL	2		Room 215	
11	L	2		Room 213	
12		1		Room 104	

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ASBESTOS BULK SAMPLE FORM

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Project Information

Client: IOWA DAS	Project Description: Girls Dorm Upgrade Project #9356	Project Manager: Steve Hudson Inspector: Steve Hudson
Date: May 29, 2024	Site Location: IA School for the Deaf Girls Dorm	ATLAS PROJECT NUMBER: 204BS07143

Sample #	Material Description	Floor	HA	Sample Location	Quantity
13	JOINT COMPOUND	2		ROOM 215	
14	├	2		ROOM 213	
15		1		ROOM 104	
16	CAULKING AROUND interior of MAPES BOARD	3		ROOM 302	
17	CARPET MASTIC (BLACK/BROWN)	2		ROOM 215	
18	4" GREY BASE COAT WITH BROWN MASTIC	2		KITCHEN - 208	
19	12"x12" FLOOR TILE (BLUE/GRAY STRAKES) AND BROWN/BLACK MASTIC	2		1	
20	2'x4' ceiling TILE - white pinhole	1		ROOM 114	
21	EPOXY FLOORING	1		Hall by ROOM 108	
22	STEAM PIPE - MUDDER FITTING	1		ROOM 108	
23	Girls HOT WATER - MUDDER Fittings	1			
24	STEAM TANK INSULATION (GREEN)	1			
25	HOT WATER PIPE - MUDDER Fittings	1			

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ASBESTOS BULK SAMPLE FORM

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Project Information

Client: IOWA DAS	Project Description: Girls Dorm Upgrade Project #9356	Project Manager: Steve Hudson Inspector: Steve Hudson
Date: May 29, 2024	Site Location: IA School for the Deaf Girls Dorm	ATLAS PROJECT NUMBER: 204BS07143

Sample #	Material Description	Floor	HA	Sample Location	Quantity
26	RECIRC PIPE-MUDDER fitting	1		ROOM 108	
27	WINDOW CAULK (GRAY) interior	1		ROOM 140	
28	Ceiling Texture white swirl	3		ROOM 328	
29	┐	3		ROOM 146	
30	┐	2		RM 225	
31	CARPET MASTIC - YELLOW	3		ROOM 328	
32	4" BASE COVE (GRAY) with BROWN MASTIC	3		ROOM 328	
33	2'x4' ceiling TILE - white pinhole/fissure	3		ROOM 146	
34	CEILING Adhesive PUCKS BROWN	1		C110 - LOBBY	
35	┐	1		┐	
36	vibration damper on duct	1		123A	
37	LEVELING COMPOUND (GRAY)	1		139	
38	CARPET MASTIC - YELLOW	1		139	

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ASBESTOS BULK SAMPLE CHAIN OF CUSTODY FORM Page ____ of ____

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Fax (402) 597-8532

Project Information

Client: IOWA DAS	Project Description:	Project Manager: Inspector:
Date: MAY 29, 2024	Site Location: IA school for Deaf - Girls dorm	ATLAS PROJECT NUMBER: 204BS07143

BULK SAMPLE LOCATION

Sample #	Material Description	Floor	Sample Location	Quantity
✓ 39	2'x2' ceiling tile white pinhole / fissure	1st	corridor 066	
✓ 40	drywall	1st	L	
✓ 41	JOINT COMPOUND	1st		
✓ 42	WINDOW GLAZING (interior)	1st	RM ~~125~~ 125	
✓ 43	CEILING TEXTURE - swirl	1st	RM 129	
✓ 44	12" x 12" floor tile (cream w/ streaks) & gold mosaic	1st	RM 122	
✓ 45	4" GRAT BASE COE & white Mastic	1st	RM 120	
✓ 46	WINDOW GLAZING interior - white powder	2nd	RM 228	
✓ 47	2'x2' ceiling tile - white pinhole	2nd	RM 248	
✓ 48	drywall	3rd	RM 3304	
✓ 49	JOINT COMPOUND	3rd	RM 306	
✓ 50	WINDOW GLAZING interior white powder	B	RM 054	
✓ 51	CAULK around window opening	Ext	61 wine - west side	

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ASBESTOS BULK SAMPLE CHAIN OF CUSTODY FORM Page ___ of ___

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Project Information

Client:	Project Description:	Project Manager: Inspector:
Date:	Site Location:	ATLAS PROJECT NUMBER: 204BS

BULK SAMPLE LOCATION

Sample #	Material Description	Floor	Sample Location	Quantity
✓ 52	CAULKING AROUND WINDOW - GRAY	EXT	71' WING - SOUTH SIDE	
✓ 53	CAULKING AROUND Lintel - WHITE	EXT	71' WING - SOUTH SIDE	
✓ 54	BRICKWORK	EXT	71' " " " "	
✓ 55	BRICK GROUT	EXT	61' " " WEST SIDE	
✓ 56	BRICK GROUT	EXT	71' " " SOUTH SIDE	
✓ 57	CAULKING BLACK AROUND RAFTS BOARD	EXT	61' " " EAST SIDE	
✓ 58	EXPANSION JOINT	EXT	71' " " NORTH SIDE	
✓ 59	CAULKING AROUND WINDOW - S. SIDE	EXT	61' " " SOUTH SIDE	

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Asbestos Bulk Building Material Chain of Custody

EMSL Order Number (Lab Use Only):

042413417

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PHONE: 1-800-220-3675
FAX: (856) 786-5974

Company: Atlas Technical (ATC55)		EMSL-Bill to: ☒ Same ☐ Different If Bill to is Different note instructions in Comments**	
Street: 11117 Mockingbird Drive		Third Party Billing requires written authorization from third party	
City: Omaha	State/Province: NE	Zip/Postal Code: 68137	Country: US
Report To (Name): Steve Hudson		Telephone #: 402-697-9747	
Email Address: steve.hudson@oneatlas.com		Fax #:	Purchase Order:
Project Name/Number: 2048507143		Please Provide Results: ☐ Fax ☒ Email ☐ Mail	
U.S. State Samples Taken: Iowa		CT Samples: ☐ Commercial/Taxable ☐ Residential/Tax Exempt	
Turnaround Time (TAT) Options* - Please Check			
☐ 3 Hour ☐ 6 Hour ☒ 24 Hour ☐ 48 Hour ☐ 72 Hour ☐ 96 Hour ☐ 1 Week ☐ 2 Week			
*For TEM Air 3 hr through 6 hr, please call ahead to schedule. *There is a premium charge for 3 Hour TEM AHERA or EPA Level II TAT. You will be asked to sign an authorization form for this service. Analysis completed in accordance with EMSL's Terms and Conditions located in the Analytical Price Guide.			
PLM - Bulk (reporting limit)		TEM - Bulk	
☒ PLM EPA 600/R-93/116 (<1%)		☐ TEM EPA NOB - EPA 600/R-93/116 Section 2.5.5.1	
☐ PLM EPA NOB (<1%)		☐ NY ELAP Method 198.4 (TEM)	
Point Count ☐ 400 (<0.25%) ☐ 1000 (<0.1%)		☐ Chatfield Protocol (semi-quantitative)	
Point Count w/Gravimetric ☐ 400 (<0.25%) ☐ 1000 (<0.1%)		☐ TEM % by Mass - EPA 600/R-93/116 Section 2.5.5.2	
☐ NIOSH 9002 (<1%)		☐ TEM Qualitative via Filtration Prep Technique	
☐ NY ELAP Method 198.1 (friable in NY)		☐ TEM Qualitative via Drop Mount Prep Technique	
☐ NY ELAP Method 198.6 NOB (non-friable-NY)		Other	
☐ OSHA ID-191 Modified		☐	
☐ Standard Addition Method			
☐ Check For Positive Stop - Clearly Identify Homogenous Group		Date Sampled: 6-28-24	
Samplers Name: Steve Hudson		Samplers Signature: [Signature]	
Sample #	HA #	Sample Location	Material Description
		SEE ATTACHED	
Client Sample # (s): 60 - 62		Total # of Samples: 3	
Relinquished (Client): [Signature]		Date: 6-28-24	Time: 5PM
Received (Lab): [Signature] FX		Date: 6/29/24	Time: 10:15 AM
Comments/Special Instructions:			

(3) AD

042413417

ASBESTOS BULK SAMPLE FORM

Page ___ of ___

11117 Mockingbird Drive
Omaha, NE 68137Phone (402) 697-9747
Fax (402) 597-8532

Project Information

Client: IOWA DAS	Project Description: GIRLS DORM	Project Manager: Steve Husson Inspector: STEVE HUSSON
Date: 6-28-24	Site Location: IA School for Deaf	ATLAS PROJECT NUMBER: 204BS07143

Sample #	Material Description	Floor	Sample Location	Quantity
60	FLOOR MASTIC (BLACK/BROWN) under carpet	2	ROOM 215	
61	FLOOR MASTIC (~~Black~~ /BROWN) under carpet	2	ROOM 218	
62	FLOOR MASTIC (BROWN/BLACK)	2	ROOM 213	

RECEIVED
EMSL
CINNAMINSON, N.J.
2024 JUN 29 A 10:29

2 of 2

APPENDIX B
LEAD PAINT TEST RESULTS

**EMSL Analytical, Inc.**

200 Route 130, Cinnaminson, NJ, 08077
Telephone: 856-858-4800 Fax:856-786-5974
EMSL-CIN-01

EMSL Order ID: 012418921
LIMS Reference ID: AC18921
EMSL Customer ID: ATC55

Attention: Steve Hudson
Atlas Technical [ATC55]
11117 Mockingbird Drive
Omaha, NE 68137
(402) 697-9747
steve.hudson@oneatlas.com

Project Name: 204BS07143 // Iowa DAS School for Deaf - Girls Dorm
Customer PO:
EMSL Sales Rep: Anthony DeRosa
Received: 06/04/2024 12:45
Reported: 06/05/2024 17:41

Analytical Results

Analyte	Results	RL	Weight(g)	Prep Date & Tech	Prep Method	Analysis Date & Analyst	Analytical Method	Q	DF
Client Sample ID: P - 1/White - Drywall - 3rd Floor Rm 147 - South Wall Below Window							Date Sampled: 05/28/24		
Matrix: Chips							LIMS Reference ID: AC18921-01		
Lead	<0.012 % wt	0.012 % wt	0.1709	06/04/24 PL	SW-846 3050B	06/05/24 PMX	SW846-7000B	1	
Sample Comments:									
Client Sample ID: P - 2/White - Plaster - 3rd Floor Rm 147 - South Wall Below Window							Date Sampled: 05/28/24		
Matrix: Chips							LIMS Reference ID: AC18921-02		
Lead	<0.008 % wt	0.008 % wt	0.2692	06/04/24 PL	SW-846 3050B	06/05/24 PMX	SW846-7000B	1	
Sample Comments:									
Client Sample ID: P - 3/White - Concrete - 3rd Floor - Rm 313 Above Window							Date Sampled: 05/28/24		
Matrix: Chips							LIMS Reference ID: AC18921-03		
Lead	0.064 % wt	0.008 % wt	0.257	06/04/24 PL	SW-846 3050B	06/05/24 PMX	SW846-7000B	1	
Sample Comments:									
Client Sample ID: P - 4/White/Yellow - Metal - Radiator Paint - Rm 302							Date Sampled: 05/28/24		
Matrix: Chips							LIMS Reference ID: AC18921-04		
Lead	<0.008 % wt	0.008 % wt	0.264	06/04/24 PL	SW-846 3050B	06/05/24 PMX	SW846-7000B	1	
Sample Comments:									
Client Sample ID: P - 5/Tan/Green - Metal - Rm 119 - Painted Ductwork							Date Sampled: 05/28/24		
Matrix: Chips							LIMS Reference ID: AC18921-05		
Lead	0.008 % wt	0.008 % wt	0.2582	06/04/24 PL	SW-846 3050B	06/05/24 PMX	SW846-7000B	1	
Sample Comments:									
Client Sample ID: P - 6/White - Concrete Block - Rm 228 - Ext Wall by Window							Date Sampled: 05/28/24		
Matrix: Chips							LIMS Reference ID: AC18921-06		
Lead	0.024 % wt	0.008 % wt	0.2549	06/04/24 PL	SW-846 3050B	06/05/24 PMX	SW846-7000B	1	
Sample Comments:									

**EMSL Analytical, Inc.**

200 Route 130, Cinnaminson, NJ, 08077
Telephone: 856-858-4800 Fax: 856-786-5974
EMSL-CIN-01

EMSL Order ID: 012418921
LIMS Reference ID: AC18921
EMSL Customer ID: ATC55

Attention: Steve Hudson
Atlas Technical [ATC55]
11117 Mockingbird Drive
Omaha, NE 68137
(402) 697-9747
steve.hudson@oneatlas.com

Project Name: 204BS07143 // Iowa DAS School for Deaf - Girls Dorm
Customer PO:
EMSL Sales Rep: Anthony DeRosa
Received: 06/04/2024 12:45
Reported: 06/05/2024 17:41

Certified Analyses included in this Report

Analyte	Certifications
SW846-7000B in Chips	
Lead	AIHA LAP

List of Certifications

Code	Description	Number	Expires
NJDEP	New Jersey Department of Environmental Protection	03036	06/30/2024
AIHA LAP	EMSL Analytical, Inc. Cinnaminson, NJ AIHA-LAP, LLC-ELLAP Accredited	100194	01/01/2025
NYSDOH	New York State Department of Health	10872	04/01/2025
California ELAP	California Water Boards	1877	06/30/2024
A2LA	A2LA Environmental Certificate	2845.01	07/31/2024
PADEP	Pennsylvania Department of Environmental Protection	68-00367	11/30/2024
MADEP	Massachusetts Department of Environmental Protection	M-NJ337	06/30/2024
CTDPH	Connecticut Department of Public Health	PH-0270	06/23/2024

Please see the specific Field of Testing (FOT) on www.emsl.com <<http://www.emsl.com>> for a complete listing of parameters for which EMSL is certified.

Notes and Definitions

Item	Definition
(Dig)	For metals analysis, sample was digested.
[2C]	Reported from the second channel in dual column analysis.
DF	Dilution Factor
MDL	Method Detection Limit.
ND	Analyte was NOT DETECTED at or above the detection limit.
Q	Qualifier
RL	Reporting Limit For paint chips, the RL is 0.008% by wt. (equiv. to 80 mg/kg, or ppm) based upon a minimum sample weight of 0.25 grams. For soils, the RL is 40 mg/kg (ppm) based upon a minimum sample weight of 0.5 grams. For dust wipes, the RL is 10 µg/wipe; reporting units of µg/sq. ft. are not validated by the lab based upon data provided by non-lab personnel.
Wet	Sample is not dry weight corrected.
Measurement of uncertainty and any applicable definitions of method modifications are available upon request. Per EPA NLLAP policy, sample results are not blank corrected.	

**EMSL Analytical, Inc.**

200 Route 130, Cinnaminson, NJ, 08077
Telephone: 856-858-4800 Fax: 856-786-5974
EMSL-CIN-01

EMSL Order ID: 012418921
LIMS Reference ID: AC18921
EMSL Customer ID: ATC55

Attention: Steve Hudson
Atlas Technical [ATC55]
11117 Mockingbird Drive
Omaha, NE 68137
(402) 697-9747
steve.hudson@oneatlas.com

Project Name: 204BS07143 // Iowa DAS School for Deaf -
Girls Dorm

Customer PO:
EMSL Sales Rep: Anthony DeRosa
Received: 06/04/2024 12:45
Reported: 06/05/2024 17:41

Owen McKenna Laboratory Manager or other approved signatory

EMSL maintains liability limited to cost of analysis. Interpretation and use of test results are the responsibility of the client. This report relates only to the samples reported above and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. The report reflects the samples as received. Results are generated from the field sampling data (sampling volumes and areas, locations, etc.) provided by the client on the Chain of Custody. QC sample results are within quality control criteria and met method specifications unless otherwise noted. All results for soil samples are reported on a dry weight basis, unless otherwise noted.

Analysis following EMSL SOP for the Determination of Environmental Lead by FLAA. The laboratory has a reporting limit of 0.008% by wt., based upon a minimum sample weight of 0.25g submitted to the lab, and is not responsible for any result or reporting limit provided in mg/cm² since it is dependent upon an area value provided by non-lab personnel. A "<" (less than) result signifies that the analyte was not detected at or above the reporting limit. Measurement of uncertainty and definitions of modifications are available upon request. Results in this report are not blank corrected unless specified.



EMSL ANALYTICAL, INC.
LABORATORY • PRODUCTS • TRAINING

Lead Chain of Custody

EMSL Order Number / Lab Use Only

EMSL Analytical, Inc.
200 Route 130 North

Cinnaminson, NJ 08077
PHONE: 1-800-220-3675
EMAIL: c@emsl.com

AC18921

Customer Information		Billing Information			
Customer ID:		Billing ID:			
Company Name: Atlas Technical Consultants, LLC		Company Name: Atlas Technical Consultants, LLC			
Contact Name: Steve Hudson		Billing Contact: Steve Hudson			
Street Address: 11117 Mockingbird Drive		Street Address: 11117 Mockingbird Drive			
City, State, Zip: Omaha NE 68137 Country: US		City, State, Zip: Omaha NE 68137 Country: US			
Phone: 14026703842		Phone: 14026703842			
Email(s) for Report: steve.hudson@oneatlas.com		Email(s) for Invoice:			
Project Information					
Project Name/No: 2048567143		Purchase Order:			
EMSL LIMS Project ID:		US State where samples collected: NE IA			
(If applicable, EMSL will provide)		State of Connecticut (CT) must select project location:			
Sampled By Name:		☐ Commercial (Taxable) ☒ Residential (Non-Taxable)			
Sampled By Signature:		No. of Samples In Shipment: 1			
Turn-Around-Time (TAT)					
☐ 3 Hour ☐ 6 Hour ☐ 24 Hour ☒ 32 Hour ☐ 48 Hour ☐ 72 Hour ☐ 96 Hour ☐ 1 Week ☐ 2 Week					
Please call ahead for large projects and/or turnaround times 6 Hours or Less. *32 Hour TAT available for select tests only; samples must be submitted by 11:30am.					
MATRIX		METHOD	INSTRUMENT	REPORTING LIMIT	SELECTION
CHIPS ☒ % by wt. ☐ ppm (mg/kg) ☐ mg/cm ²		SW 846-7000B	Flame Atomic Absorption	0.008% (80ppm)	☒
Reporting Limit based on a minimum 0.25g sample weight		SW 846-6010D	ICP-OES	0.0004% (4ppm)	☐
AIR		NIOSH 7082	Flame Atomic Absorption	4µg/filter	☐
		NIOSH 7300M / NIOSH 7303M	ICP-OES	0.5µg/filter	☐
		NIOSH 7300M / NIOSH 7303M	ICP-MS	0.05µg/filter	☐
WIPE ☐ ASTM ☐ NON-ASTM		SW 846-7000B	Flame Atomic Absorption	10µg/wipe	☐
If no box is checked, non-ASTM Wipe is assumed		SW 846-6010D	ICP-OES	1.0µg/wipe	☐
TCLP		SW 846-1311 / 7000B / SM 3111B	Flame Atomic Absorption	0.4 mg/L (ppm)	☐
		SW 846-1311 / SW 846-6010D*	ICP-OES	0.1 mg/L (ppm)	☐
SPLP		SW 846-1312 / 7000B / SM 3111B	Flame Atomic Absorption	0.4 mg/L (ppm)	☐
		SW 846-1312 / SW 846-6010D*	ICP-OES	0.1 mg/L (ppm)	☐
TTLC		22 CCR App. II, 7000B	Flame Atomic Absorption	40mg/kg (ppm)	☐
		22 CCR App. II, SW 846-6010D*	ICP-OES	2mg/kg (ppm)	☐
STLC		22 CCR App. II, 7000B	Flame Atomic Absorption	0.4 mg/L (ppm)	☐
		22 CCR App. II, SW 846-6010D*	ICP-OES	0.1 mg/L (ppm)	☐
Soil		SW 846-7000B	Flame Atomic Absorption	40mg/kg (ppm)	☐
		SW 846-6010D*	ICP-OES	2mg/kg (ppm)	☐
Wastewater		SM 3111B / SW 846-7000B	Flame Atomic Absorption	0.4 mg/L (ppm)	☐
Unpreserved ☐		EPA 200.7	ICP-OES	0.020 mg/L (ppm)	☐
Preserved with HNO ₃ ☐ PH<2		EPA 200.5	ICP-OES	0.003 mg/L (ppm)	☐
Drinking Water		EPA 200.8	ICP-MS	0.001 mg/L (ppm)	☐
Unpreserved ☐					☐
Preserved with HNO ₃ ☐ PH<2					☐
TSP/SPM Filter		40 CFR Part 50	ICP-OES	12 µg/filter	☐
Other:					☐
Sample Number		Sample Location	Volume / Area	Date / Time Sampled	
		SEE ATTACHED			
Method of Shipment:		Sample Condition Upon Receipt:			
Relinquished by: [Signature]		Date/Time: 5/20/24	Received by: [Signature]	Date/Time: 6/14/24	Received by: [Signature]
Relinquished by:		Date/Time:	Received by:	Date/Time:	Received by:

Controlled Document - COC-25 Lead R16 4/19/2021

*6010C Available Upon Request

☒ AGREE TO ELECTRONIC SIGNATURE (By checking, I consent to signing this Chain of Custody document by electronic signature.)

EMSL Analytical, Inc.'s Laboratory Terms and Conditions are incorporated into this Chain of Custody by reference in its entirety. Submission of samples to EMSL Analytical, Inc. constitutes acceptance and acknowledgment of all terms and conditions by Customer.

A C18921

PAINT CHIP SAMPLE LOG SHEET

Page ___ of ___

ATLAS11117 Mockingbird Drive
Omaha, NE 68137

Phone (402) 697-9747

Project Information

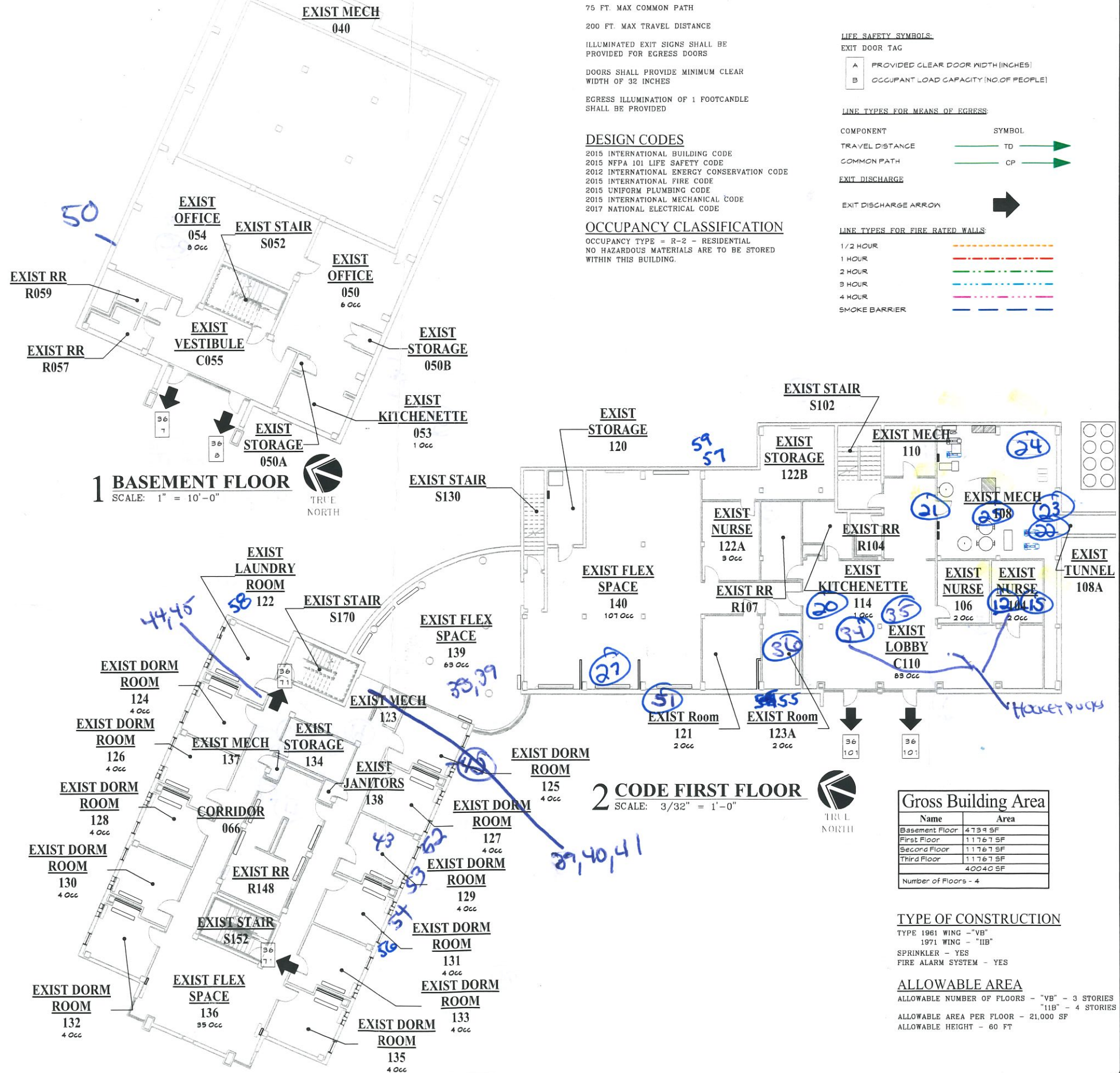
Client: IOWA DAS	Project Description:	Project Manager: ~~SEB~~ Inspector: TIM JACOBSEN
Date: 5-28-24	Site Location: IOWA school for DEAF-GIRL'S DORM	ATLAS PROJECT NUMBER: 204BS07143

Sample #	Paint Color	Substrate	Sample Location	Quantity
✓ P-1	white	ORT WALL	3RD FLOOR, RM 147, SOUTH wall below window	
✓ P-2	white	PLASTER	11	
✓ P-3	white	concrete	3RD FLOOR - RM 313 ABOVE WINDOWS	
✓ P-4	white/ YELLOW	METAL	RADIATOR PAINT - RM 302	
✓ P-5	Tan/ GREEN	METAL	RM 119 - Painted outwork	
✓ P-6	white	concrete block	RM 228 - Ext wall by window	

APPENDIX C
SAMPLE LOCATIONS

IBC 2015 Occupancy Loads by Room

Rm#	Room Name	Area	Function of Space	Load Factor	Occupants
BASEMENT FLOOR					
050	EXIST OFFICE	514 SF	Business Area	100 SF	6
053	EXIST KITCHENETTE	108 SF	Kitchen - Commercial	200 SF	1
054	EXIST OFFICE	713 SF	Business Area	100 SF	5
BASEMENT FLOOR					
FIRST FLOOR					
104	EXIST NURSE	141 SF	Institutional Area - Sleeping	120 SF	2
106	EXIST NURSE	141 SF	Institutional Area - Outpatient	100 SF	2
114	EXIST KITCHENETTE	99 SF	Kitchen - Commercial	200 SF	1
121	EXIST ROOM	185 SF	Institutional Area - Sleeping	120 SF	2
122A	EXIST NURSE	202 SF	Institutional Area - Outpatient	100 SF	3
123A	EXIST ROOM	126 SF	Institutional Area - Sleeping	120 SF	2
124	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
125	EXIST DORM ROOM	178 SF	Dormitories	50 SF	4
126	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
127	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
128	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
129	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
130	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
131	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
132	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
133	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
135	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
136	EXIST FLEX SPACE	515 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	35
139	EXIST FLEX SPACE	432 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	63
140	EXIST FLEX SPACE	1599 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	107
C110	EXIST LOBBY	1232 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	83
FIRST FLOOR					
SECOND FLOOR					
118	EXIST FLEX SPACE	926 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	62
205	EXIST DORM ROOM	251 SF	Dormitories	50 SF	6
207	EXIST DORM ROOM	235 SF	Dormitories	50 SF	5
208	EXIST KITCHEN & DINING	542 SF	Kitchen - Commercial	200 SF	3
209	EXIST DORM ROOM	238 SF	Dormitories	50 SF	5
211	EXIST DORM ROOM	236 SF	Dormitories	50 SF	5
213	EXIST DORM ROOM	238 SF	Dormitories	50 SF	5
215	EXIST DORM ROOM	235 SF	Dormitories	50 SF	5
216	EXIST DORM ROOM	225 SF	Dormitories	50 SF	5
217	EXIST DORM ROOM	238 SF	Dormitories	50 SF	5
218	EXIST DORM ROOM	240 SF	Dormitories	50 SF	5
219	EXIST DORM ROOM	235 SF	Dormitories	50 SF	5
220	EXIST DORM ROOM	238 SF	Dormitories	50 SF	5
222	EXIST DORM ROOM	173 SF	Dormitories	50 SF	4
223	EXIST DORM ROOM	178 SF	Dormitories	50 SF	4
224	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
225	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
226	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
227	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
228	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
229	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
230	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
231	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
232	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
233	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
250	EXIST FLEX SPACE	540 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	37
SECOND FLOOR					
THIRD FLOOR					
145	EXIST FLEX SPACE	526 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	36
146	EXIST FLEX SPACE	926 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	62
147	EXIST FLEX SPACE	605 SF	Assembly without Fixed Seats - Tables & Chairs	15 SF	41
148	EXIST DORM ROOM	235 SF	Dormitories	50 SF	5
300	EXIST DORM ROOM	237 SF	Dormitories	50 SF	5
301	EXIST DORM ROOM	277 SF	Dormitories	50 SF	6
302	EXIST DORM ROOM	238 SF	Dormitories	50 SF	5
303	EXIST DORM ROOM	214 SF	Dormitories	50 SF	5
306	EXIST OFFICE	145 SF	Business Area	100 SF	2
311	EXIST DORM ROOM	234 SF	Dormitories	50 SF	5
313	EXIST DORM ROOM	237 SF	Dormitories	50 SF	5
315	EXIST DORM ROOM	234 SF	Dormitories	50 SF	5
316	EXIST DORM ROOM	223 SF	Dormitories	50 SF	5
317	EXIST DORM ROOM	237 SF	Dormitories	50 SF	5
318	EXIST DORM ROOM	239 SF	Dormitories	50 SF	5
319	EXIST DORM ROOM	239 SF	Dormitories	50 SF	5
320	EXIST DORM ROOM	237 SF	Dormitories	50 SF	5
322	EXIST DORM ROOM	173 SF	Dormitories	50 SF	4
323	EXIST DORM ROOM	178 SF	Dormitories	50 SF	4
324	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
325	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
326	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
327	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
328	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
329	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
330	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
331	EXIST DORM ROOM	167 SF	Dormitories	50 SF	4
332	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
333	EXIST DORM ROOM	164 SF	Dormitories	50 SF	4
THIRD FLOOR					
Grand total					
					820



this drawing is being made available by hgm associates inc. for use on this project in accordance with hgm associates inc. agreement for professional services, hgm associates inc. assumes no liability for any use of this drawing or any part thereof except in accordance with the terms of the above agreement.

	Rev#	Date
HGM drawn	1	Date 1
HGM designed		
HGM approved		
3-22-24 date		

Project **GIRL'S DORM UPGRADES**
3501 Harry Langdon Blvd, Council Bluffs, IA 51503

CODE PLAN

project no.
105023A
9356.00

G1.4



Photo Log

Girls Dorm Upgrade Project ■ Iowa School for Deaf, Council Bluffs, IA
Date Taken: May-28-29, 2024 ■ Atlas Project No. 204BS07143



Photo #1 Asbestos pipe fittings – Wing 61 – Mech Room 108



Photo #2 Asbestos Containing Tank Insulation – Wing 61 – Mech Room 108



Photo #3 Asbestos containing mastic remnants under carpet – Wing 61 – Room 215.



Photo #4 Asbestos window glazing on inoperable windows in Wing 71.



Photo #5 Overview of inoperable windows on Wing 71.

APPENDIX D
STAFF ACCREDITATIONS

January 3, 2024

Phillip M Thomas
12919 Church Road
Louisville, NE 68037

Dear Phillip M Thomas

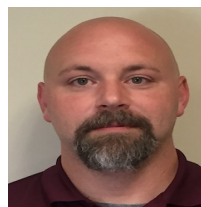
The department has reviewed the information you submitted and determined that you have met the requirements for certification in the state of Iowa as a Lead Inspector/Risk Assessor. Your certification number is: LEAD-INSP10076.

Your certification will expire on February 28, 2027. By that date, you must renew your certification in order to perform any lead professional certification activities. To renew your certification, you will need to have completed the appropriate refresher course. Refresher courses are valid if taken within 3-years from the date that you renew.

Please keep a copy of your certification on your person or in an easily retrievable area at the work site. If you submitted your application online or with a valid email address, the certification is being provided to you electronically. You may choose to either print these documents or have them available on your phone or other electronic device for display if requested.

You can find the certification requirements and work practice standards for all lead professionals in Iowa Administrative Code 641 - Chapter 70, which is at: <http://www.idph.iowa.gov/LPP> under "Resources". You **must** be currently certified to perform work that requires certification.

Bureau of Environmental Health Services
Lead Professional Certification
Phone: 800-972-2026
E-mail: Lead.Bureau@idph.iowa.gov



**IOWA DEPARTMENT
OF PUBLIC HEALTH**

Phillip M Thomas
**Lead Inspector/Risk
Assessor**

Certification Number: LEAD-INSP10076

Expiration Date: February 28, 2027

STEVE HUDSON

DOB: 05-26-1970

Issued: 02-15-2024



This person is licensed to perform asbestos work in the State of Iowa. ID card is intended for official use only and must be present on jobsite.

License Type	Number	Expires
INSPECTOR	24-11325	01-23-2025

IOWA

Asbestos

A handwritten signature in black ink, appearing to read "Larry Johnson, Jr.", enclosed within a rectangular box.

**Larry Johnson, Jr.
Labor Commissioner**

END OF VOLUME 02

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