SECTION 00 0101
PROJECT TITLE PAGE

FOR
IOWA DEPARTMENT OF TRANSPORTATION
D4 AVOCA MAINTENANCE FACILITY - ELECTRICAL UPGRADE
1110 N CHESTNUT ST.
AVOCA, IA 51521

PROJECT MANUAL
BUILDING SPECIFICATIONS FOR: AVOCA MAINTENANCE FACILITY - ELECTRICAL UPGRADE
DATE: MAY 2022

END OF SECTION

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END OF SECTION

SECTION 01 1000
SUMMARY

PART 1 GENERAL

PROJECT

1.01 PROJECT NAME: D4 AVOCA MAINTENANCE FACILITY - ELECTRICAL UPGRADE

1.02 OWNER'S NAME: IOWA DEPARTMENT OF TRANSPORTATION.

1.03 IADOT PROJECT MANAGER'S NAME: IADOT - FACILITIES DESIGN AND INSPECTION - SUPPORT SERVICES.

1.04 THE PROJECT CONSISTS OF THE ALTERATION OF EXISTING ELECTRICAL SYSTEM.

1.05 CONTRACT DESCRIPTION

A. Contract Type: Stipulated Price as described in Standard form of Agreement Between the Contractor and Owner, as provided by Iowa DOT purchasing.

1.06 DESCRIPTION OF ALTERATIONS WORK

A. Scope of alterations work is indicated on drawings.

B. Electrical Power and Lighting: Alter existing system and add new construction, keeping existing in operation.

1.07 OWNER OCCUPANCY

A. Owner intends to continue to occupy all [_____] portions of the existing building during the entire construction period.

B. Construction, including punch list items, must be completed no later than date noted in Purchasing Documents

1. Extension requests must be in writing and must be accompanied by appropriate documentation supporting the reason for the extension request.

2. No extensions or additional payments will be allowed for cold weather construction.

C. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

D. Schedule the Work to accommodate Owner occupancy.

1.08 CONTRACTOR USE OF SITE AND PREMISES

A. Arrange use of site and premises to allow:
   1. Owner occupancy.

B. Provide access to and from site as required by law and by Owner:
   1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
   2. Do not obstruct roadways, sidewalks, or other public ways without permit.

C. Time Restrictions:
   1. Limit conduct of the hours of 7:30am to 3:30pm unless other authorized by the Project Manager.
   2. Facility Operational "Off Hours" extension: Contractor may request, in writing to the Project Manager, to perform construction operations during Off Hours. If granted, the Contractor must have a representative present during any Sub-Contractor work..

D. Utility Outages and Shutdown:
   1. Limit shutdown of utility services to 1 hour at a time during work hours, unless otherwise authorized by the IaDOT Project Manager, and arranged at least 24 hours in advance.
   2. Prevent accidental disruption of utility services to other facilities.

1.09 WORK SEQUENCE

A. Coordinate construction schedule and operations with IaDOT Project Manager.

1.10 SPECIFICATION CONVENTIONS

A. These specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

1.11 SPECIFICATION SECTIONS APPLICABLE TO ALL CONTRACTS

A. Unless otherwise noted, all provisions of the sections listed below apply to all contracts. Specific items of work listed under individual contract descriptions constitute exceptions.

B. Section 01 2000 - Price and Payment Procedures.

C. Section 01 2300 - Alternates.

D. Section 01 3000 - Administrative Requirements.

E. Section 01 4000 - Quality Requirements.

F. Section 01 6000 - Product Requirements.

G. Section 01 7000 - Execution and Closeout Requirements.

H. Section 01 7800 - Closeout Submittals.

END OF SECTION

SECTION 01 2000
PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

1.02 SCHEDULE OF VALUES

A. Use Schedule of Values Form: AIA G703.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to IaDOT Project Manager for approval.

C. Forms filled out by hand will not be accepted.

D. Submit Schedule of Values within 15 days after date of Owner-Contractor Agreement.

E. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification section. Identify site mobilization.

F. Include within each line item, a direct proportional amount of Contractor's overhead and profit.

G. Revise schedule to list approved Change Orders, with each Application For Payment.

1.03 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Use Form AIA G702 & AIA G703.

C. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to IaDOT Project Manager IaDOT Project Manager for approval.

D. Forms filled out by hand will not be accepted.

E. For each item, provide a column for listing each of the following:
   1. Item Number.
   2. Description of work.
   3. Scheduled Values.
   4. Previous Applications.
   5. Work in Place and Stored Materials under this Application.
   6. Authorized Change Orders.
   7. Total Completed and Stored to Date of Application.
   8. Percentage of Completion.
   9. Balance to Finish.
   10. Retainage.

F. Execute certification by signature of authorized officer.

G. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.

H. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.

I. Submit one electronic and one hard-copies of each Application for Payment.

J. Include the following with the application:
   1. Transmittal letter as specified for submittals in Section 01 3000.
   2. Construction progress schedule, revised and current as specified in Section 01 3000.
   3. Current construction photographs specified in Section 01 3000.

K. When IaDOT Project Manager requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.04 MODIFICATION PROCEDURES

A. For minor changes not involving an adjustment to the Contract Sum or Contract Time, IaDOT Project Manager will issue instructions directly to Contractor.

B. For other required changes, IaDOT Project Manager will issue an AIA Document G701 change order document signed by Iowa Department of Transportation instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
   1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
   2. Promptly execute the change.3. Change Orders must be approved by the IaDOT Project Manager, Contractor and IDOT
   3. Change Orders must be approved by the IaDOT Project Manager, Contractor and IDOT prior to work beginning. If Contractor performs work before Change Order is approved by all parties, the Contractor will not receive remuneration or will return project to original condition at behest of the IaDOT Project Manager and at no cost to Owner.

C. For changes for which advance pricing is desired, IaDOT Project Manager will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Time for executing the change with a stipulation of any overtime work required and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within 5 days.

D. Contractor may propose a change by submitting a request for change to IaDOT Project Manager, describing the proposed change and its full effect on the work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation. Document any requested substitutions in accordance with Section 01 6000.

E. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
   1. For change requested by Contractor, the amount will be based on the Contractor's request for a Change Order as approved by IaDOT Project Manager.
   2. For change ordered by IaDOT Project Manager without a quotation from Contractor, the amount will be determined by IaDOT Project Manager based on the Contractor's substantiation of costs as specified for Time and Material work.

F. Substantiation of Costs: Provide full information required for evaluation.
   1. Provide the following data:
      a. Quantities of products, labor, and equipment.
      b. Overhead and profit.
      c. 1) Will not exceed 15 percent total between General Contractor and Sub Contractor.
   2. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.

G. Execution of Change Orders: IaDOT Project Manager will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

H. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

I. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.

J. Promptly enter changes in Project Record Documents.

1.05 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following have been accomplished:
   1. All closeout procedures specified in Section 01 7000.
   2. All Punch List items have been completed..

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 3000
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preconstruction meeting.

B. Site mobilization meeting.

C. Progress meetings.

D. Construction progress schedule.

E. Progress photographs.

F. Coordination drawings.

G. Submittals for review, information, and project closeout.

H. Number of copies of submittals.

I. Submittal procedures.

1.02 RELATED REQUIREMENTS

A. Section 01 7000 - Execution and Closeout Requirements: Additional coordination requirements.

B. Section 01 7800 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.

1.03 PROJECT COORDINATION

A. Project Coordinator: Contracto.

B. Cooperate with the Project Coordinator in allocation of mobilization areas of site; for field offices and sheds, for vehicular access, traffic, and parking facilities.

C. During construction, coordinate use of site and facilities through the Project Coordinator.

D. Comply with Project Coordinator's procedures for intra-project communications; submittals, reports and records, schedules, coordination drawings, and recommendations; and resolution of ambiguities and conflicts.

E. Comply with instructions of the Project Coordinator for use of temporary utilities and construction facilities. Responsibility for providing temporary utilities and construction facilities is identified in Section 01 1000 - Summary.

F. Coordinate field engineering and layout work under instructions of the Project Coordinator.

G. Make the following types of submittals to IaDOT Project Manager through the Project Coordinator:
   1. Requests for Interpretation.
   2. Requests for substitution.
   3. Shop drawings, product data, and samples.
   4. Test and inspection reports.
   5. Design data.
   6. Manufacturer's instructions and field reports.
   7. Applications for payment and change order requests.
   8. Progress schedules.
   9. Coordination drawings.
   10. Correction Punch List and Final Correction Punch List for Substantial Completion.
   11. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. IaDOT Office of Facilities Design & Inspection, Support Services Bureau's Project Managerwill schedule a meeting after Notice of Award.

B. Attendance Required:
   1. IaDOT local Maintenance Garage Supervisor,
   2. IaDOT Office of Facilities Design & Inspection, Support Services Bureau's Project Manager,
   3. IaDOT Consultants/Engineers,
   4. Contractor,
   5. All major Sub-Contractors.

C. Agenda:
   1. Submission of list of subcontractors, list of products, schedule of values, and progress schedule shall be supplied to the IaDOT Project Manager prior to this meeting, and shall be discussed during the Preconstruction Meeting.
   2. Designation of personnel representing the parties to Contract IaDOT Facilities Design & Inspection, Support Services Bureau's Project Manager.
   3. Review procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
   4. Coordinate commencement of contstruction.
   5. Use of premises by Owner and Contractor.
   6. Temporary utilities provided by Contractor.
   7. Security and housekeeping procedures.
   8. Procedures for testing.
   9. Procedures for maintaining record documents.
   10. Requirements for start-up of equipment.
   11. Inspection and acceptance of equipment put into service during construction period.
   12. Scheduling.

D. Record minutes and distribute copies within two days after meeting to participants, with two copies to IaDOT Project Manager, Owner, participants, and those affected by decisions made.

3.02 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the work at maximum bi-weekly intervals.

B. Project Coordinator (Contractor) will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

C. Attendance Required: Job Superintendent, major Subcontractors and suppliers, Owner, Architect/Engineer, as appropriate to agenda topics for each meeting.
   1. Contractor.
   2. Owner.
   3. IaDOT Project Manager.
   4. Special consultants.
   5. Contractor's superintendent.
   6. Major subcontractors.
   7. As needed: IaDOT Consultants/Engineers,.

D. Agenda:
   1. Review minutes of previous meetings.
   2. Review of Work progress.
   3. Field observations, problems, and decisions.
   4. Identification of problems that impede, or will impede, planned progress.

5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Status of Proposal Requests, Change Orders, Architect's Supplemental Instructions and Requests For Information. Maintenance of quality and work standards.
12. Maintenance of quality and work standards.
13. Effect of proposed changes on progress schedule and coordination.
14. Other business relating to work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to IaDOT Project Manager, Owner, participants, and those affected by decisions made.

3.03 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 01 3216

A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.

B. If preliminary schedule requires revision after review, submit revised schedule within 7 days.

C. Within 7 days after joint review, submit complete schedule.

D. Submit updated schedule with each Application for Payment.

3.04 PROGRESS PHOTOGRAPHS

A. Submit photographs with each application for payment, taken not more than 3 days prior to submission of application for payment.

B. Photography Type: Digital; electronic files.

C. Provide photographs of site and construction throughout progress of work produced by an experienced photographer, acceptable to IaDOT Project Manager.

D. Views:
1. Provide non-aerial photographs from four cardinal views at each specified time, until date of Substantial Completion.
2. Consult with IaDOT Project Manager for instructions on views required.
3. Provide factual presentation.
4. Provide correct exposure and focus, high resolution and sharpness, maximum depth of field, and minimum distortion.

E. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
1. Delivery Medium: Via email.
2. File Naming: Include project identification, date and time of view, and view identification.
3. Point of View Sketch: Include digital copy of point of view sketch with each electronic submittal; include point of view identification in each photo file name.

3.05 COORDINATION DRAWINGS

A. Provide information required by Project Coordinator for preparation of coordination drawings.

B. Review drawings prior to submission to IaDOT Project Manager.

3.06 SUBMITTALS FOR REVIEW

A. When the following are specified in individual sections, submit them for review:
1. Product data.
2. Shop drawings.
3. Samples for selection.
4. Samples for verification.

B. Submit to IaDOT Project Manager for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 7800 - Closeout Submittals.

3.07 SUBMITTALS FOR INFORMATION

A. When the following are specified in individual sections, submit them for information:
   1. Design data.
   2. Certificates.
   3. Test reports.
   4. Inspection reports.
   5. Manufacturer's instructions.
   6. Other types indicated.
   7. Manufacturer's field reports.
   8. Other types indicated.

B. Submit for IaDOT Project Manager's knowledge as contract administrator or for Iowa Department of Transportation. No action will be taken.

3.08 NUMBER OF COPIES OF SUBMITTALS

A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.

B. Documents for Information: Submit one copy electronically.

C. Samples: Submit the number specified in individual specification sections; one of which will be retained by IaDOT Project Manager.
   1. After review, produce duplicates.
   2. Retained samples will not be returned to Contractor unless specifically so stated.

3.09 SUBMITTAL PROCEDURES

General Requirements:

A. Shop Drawing Procedures:
   1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
   2. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

B. Transmit each submittal with AIA Form G810, or Contractor's standard form.

C. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.

D. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.

E. Apply Contractor's Stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirments of the Work and Contract Documents.

F. Deliver submittals to IaDot Project Manager in electronic format only.
   1. Only physical samples to be submitted to IaDot Project Manager at business address.

G. Schedule submittals to expedite the Project, and coordinate submission of related items.

H. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.

I. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.

J. Provide space for Contractor's and IaDot Project Manager's or Consulting Engineer's review stamps.

K. When revised for resubmission, identify all changes made since previous submission.

L. Distribute reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

M. Submittals not requested will not be recognized of processed.

END OF SECTION

SECTION 01 4000
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. References and Standards.

B. Submittals.

C. References and standards.

D. -

E. Control of installation.

F. Tolerances.

G. Testing and inspection agenices and services.

H. Control of installation.

I. Manufacturers' field services.

J. Defect Assessment

1.02 RELATED REQUIREMENTS

A. Section 01 3000 - Administrative Requirements: Submittal procedures.

B. Section 01 6000 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants 2008 (Reapproved 2019).

B. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation 2017.

C. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry 2022.

D. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction 2019.

E. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection 2021.

F. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing 2021.

G. ASTM E699 - Standard Specification for Agencies Involved in Testing, Quality Assurance, and Evaluating of Manufactured Building Components 2016.

H. IAS AC89 - Accreditation Criteria for Testing Laboratories 2021.

1.04 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

C. Obtain copies of standards where required by product specification sections.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from IaDOT Project Manager before proceeding.

F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of IaDOT Project Manager shall be altered from Contract Documents by mention or

inference otherwise in any reference document.

1.05 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Contractor Employed Agency:
   1. Testing Equipment: Calibrated at reasonable intervals either by NIST or using an NIST established Measurement Assurance Program, under a laboratory measurement quality assurance program.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from IaDOT Project Manager before proceeding.

D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from IaDOT Project Manager before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.03 TESTING AND INSPECTION

A. See individual specification sections for testing required.

B. Re-testing required because of non-compliance with specified requirements shall be performed by the same agency on instructions by IaDOT Project Manager.

C. Re-testing required because of non-compliance with specified requirements shall be paid for by Contractor.

3.04 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.05 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not complying with specified requirements.

END OF SECTION

SECTION 01 4100
REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY OF REFERENCE STANDARDS

A. Regulatory requirements applicable to this project are the following:

B. 28 CFR 35 - Nondiscrimination on the Basis of Disability in State and Local Government Services; Final Rule; Department of Justice current edition.

C. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines current edition.

D. ADA Standards - 2010 ADA Standards for Accessible Design 2010.

E. 29 CFR 1910 - Occupational Safety and Health Standards current edition.

F. State of Iowa amendments to some or all of the following.

G. ICC A117.1 - Accessible and Usable Buildings and Facilities 2017.

H. ICC (IFC) - International Fire Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. ICC (IBC) - International Building Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

J. ICC (IPC) - International Plumbing Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. ICC (IMC) - International Mechanical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

L. ICC (IECC) - International Energy Conservation Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.02 RELATED REQUIREMENTS

A. Section 01 4000 - Quality Requirements.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 5000
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary utilities.
   1. Field offices and sheds.
   2. Vehicular access.
   3. Parking.
   4. Progress cleaning and waste removal.
   5. Traffic Regulation

B. Temporary telecommunications services.

C. Temporary sanitary facilities.

D. Temporary Controls:
   1. Water control
   2. Dust control
   3. Noise control
   4. Pest control.
   5. Pollution control.
   6. Rodent control.

E. Temporary telecommunications services.

F. Temporary Controls: Barriers, enclosures, and fencing.

G. Vehicular access and parking.

H. Waste removal facilities and services.

I. Field offices.

1.02 TEMPORARY UTILITIES

A. IaDOT will provide the following:
   1. Electrical power, consisting of connection to existing facilities.
   2. Water supply, consisting of connection to existing facilities.

B. Use trigger-operated nozzles for water hoses, to avoid waste of water.

1.03 TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

B. Telecommunications services shall include:
   1. Internet Connections: Minimum of one; DSL modem or faster.
   2. Email: Account/address reserved for project use.

1.04 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.

B. Existing facilities may not be used during construction operations.

C. Maintain daily in clean and sanitary condition.

D. At end of construction, return facilities to same or better condition as originally found.

1.05 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
   1. Provide 4'-0" high minimum vinyl construction fencing unless otherwise noted drawings.

B. Provide barricades or fencing around any excavated holes or trenches as per OSHA requirements until they are backfilled.

C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.06 INTERIOR ENCLOSURES

A. Provide temporary partitions as indicated to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.

B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces:

1.07 SECURITY

A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

1.08 VEHICULAR ACCESS AND PARKING

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.

B. Coordinate access and haul routes with governing authorities and Owner.

C. Provide and maintain access to fire hydrants, free of obstructions.

D. Provide means of removing mud from vehicle wheels before entering streets.

E. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

F. Existing parking areas may be used for construction parking.

G. Do not allow vehicle parking on existing pavement outside of the Project Site.

1.09 WASTE REMOVAL

A. See Section 01 7419 - Construction Waste Management and Disposal, for additional requirements.

B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

C. Provide containers with lids. Remove trash from site periodically.

D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.10 PROJECT IDENTIFICATION

A. No signs are allowed without IaDOT Project Manager's permission, except those required by law.

1.11 FIELD OFFICES

A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.

B. Provide space for Project meetings, with table and chairs to accommodate 12 persons.

C. Locate offices a minimum distance of 30 feet from existing structures.

1.12 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.

B. Remove underground installations to a minimum depth of 2 feet.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition.

E. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 6000
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General product requirements.

B. Transportation, handling, storage and protection.

C. Product option requirements.

D. Substitution limitations and procedures.

E. Procedures for Iowa Department of Transportation-supplied products.

F. Maintenance materials, including extra materials, spare parts, tools, and software.

1.02 RELATED REQUIREMENTS

A. Document 00 2113 - Instructions to Bidders: Product options and substitution procedures prior to bid date.

B. Section 01 1000 - Summary: Lists of products to be removed from existing building.
   1. Section 01 1000 - Summary: Identification of Owner-supplied products.

   Section 01 2500 - Substitution Procedures: Substitutions made during procurement and/or construction phases.

C. Section 01 4000 - Quality Requirements: Product quality monitoring.
   Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

D. Section 01 7419 - Construction Waste Management and Disposal: Waste disposal requirements potentially affecting product selection, packaging and substitutions.

E. Section 22 0513 - Common Motor Requirements for Plumbing Equipment: Motors for plumbing equipment.

F. Section 23 0513 - Common Motor Requirements for HVAC Equipment: Motors for HVAC equipment.

1.03 REFERENCE STANDARDS

A. 16 CFR 260.13 - Guides for the Use of Environmental Marketing Claims; Federal Trade Commission; Recycled Content; Currnent Edition.

B. NEMA MG 1 - Motors and Generators; 2014.

C. GreenSeal GS-36 - Commercial Adhesives; Green Seal, Inc.; 2000.

D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 SUBMITTALS

A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
   1. Submit within 15 days after date of Agreement.
   2. For products specified only by reference standards, list applicable reference standards.

B. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

D. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
   1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by Contract Documents.

B. DO NOT Use products having any of the following characteristics:
   1. Made using or containing CFC's or HCFC's.
   2. Made of wood from newly cut old growth timber.

C. Where other criteria are met, Contractor shall give preference to products that:
   If used on interior, have lower emissions, as defined in Section 01 6116.
   If wet-applied, have lower VOC content, as defined in Section 01 6116.
   1. Are extracted, harvested, and/or manufactured closer to the location of the project.
   2. Have longer documented life span under normal use.
   3. Result in less construction waste. See Section 01 7419
   4. Are made of vegetable materials that are rapidly renewable.

D. Adhesives and Joint Sealants:
   1. Definition: This provision applies to gunnable, trowelable, and liquid-applied adhesives, sealants, and sealant primers used anywhere on the interior of the building inside the weather barrier, including duct sealers.
   2. Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No. 1168.
      a. Require each installer to certify compliance and submit product data showing product content.
   3. Specific Product Categories: Comply with limitations specified elsewhere.

E. Aerosol Adhesives:
   1. Provide only products having lower volatile organic compound (VOC) content than required by GreenSeal GS-36.
   2. Specific Product Categories: Comply with limitations specified elsewhere.

F. Provide interchangeable components of the same manufacture for components being replaced.

G. Motors: Refer to Section 22 0513 - Common Motor Requirements for Plumbing Equipment, NEMA MG 1 Type. Specific motor type is specified in individual specification sections.

H. Motors: Refer to Section 23 0513 - Common Motor Requirments for HVAC Equipment, NEMA MG 1 Type. Specific motor type is specified in individual specification sections.

I. Wiring Terminations: Provide terminal lugs to mach branch circuit conductor quantities, sizes, and materials indicated. Size terminal lugs to NFPA 70, include lugs for terminal box.

J. Cord and Plug: Provide minimum 6 foot cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

2.02 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.03 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION PROCEDURES

A. Instructions to Bidders specifies time restrictions for submitting requests for substitutions during the bidding period and the documents required. Comply with requirements specified in Section 00 2113.

B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.

C. Document each request with complete data substantiating complianc of proposed substitution with Contract Documents.

D. A request for substitution constitutes a representation othat the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to owner.
   4. Waives claims for additional costs or time extension that may subsequently become apparent.
   5. Will reimburse Owner and Architect/Engineer for review or redesign servies associated with re-approval by authorities.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without seperate written request, or when acceptance will require revision to the Contract Documents.

F. Substitution Submittal Procedure (after contract award)
   1. Submitt three copies of request for substitution for consideration. Limit each request to one proposed substitution.
   2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
   3. Architect will notify Contractor in writing of decision to accept or reject request.

3.02 OWNER-SUPPLIED PRODUCTS

A. See Section 01 1000 - Summary for identification of Iowa Department of Transportation-supplied products.

B. Iowa Department of Transportation's Responsibilities:
   1. Arrange for and deliver Iowa Department of Transportation reviewed shop drawings, product data, and samples, to Contractor.
   2. Arrange and pay for product delivery to site.
   3. On delivery, inspect products jointly with Contractor.
   4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
   5. Arrange for manufacturers' warranties, inspections, and service.

C. Contractor's Responsibilities:
   1. Review Iowa Department of Transportation reviewed shop drawings, product data, and samples.
   2. Receive and unload products at site; inspect for completeness or damage jointly with Iowa Department of Transportation.
   3. Handle, store, install and finish products.
   4. Repair or replace items damaged after receipt.

3.03 TRANSPORTATION AND HANDLING

A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.

B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.

D. Transport and handle products in accordance with manufacturer's instructions.

E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.

F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.

H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.04 STORAGE AND PROTECTION

A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication. See Section 01 7419.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.

G. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.

H. Comply with manufacturer's warranty conditions, if any.

I. Do not store products directly on the ground.

J. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

K. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

L. Prevent contact with material that may cause corrosion, discoloration, or staining.

M. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

N. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION

SECTION 01 7000
EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Examination, preparation, and general installation procedures.

B. Pre-installation meetings.

C. Cutting and patching.

D. Surveying for laying out the work.

E. Cleaning and protection.

F. Starting of systems and equipment.

G. Demonstration and instruction of Iowa Department of Transportation personnel.

H. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

I. General requirements for maintenance service.

1.02 RELATED REQUIREMENTS

A. Section 01 1000 - Summary: Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.

B. Section 01 3000 - Administrative Requirements: Submittals procedures, Electronic document submittal service.

C. Section 01 4000 - Quality Requirements: Testing and inspection procedures.

D. Section 01 5000 - Temporary Facilities and Controls: Temporary exterior enclosures.

E. Section 01 5000 - Temporary Facilities and Controls: Temporary interior partitions.

F. Section 01 5100 - Temporary Utilities: Temporary heating, cooling, and ventilating facilities.

G. Section 01 5713 - Temporary Erosion and Sediment Control: Additional erosion and sedimentation control requirements.

H. Section 01 7419 - Construction Waste Management and Disposal: Additional procedures for trash/waste removal, recycling, salvage, and reuse.

I. Section 01 7800 - Closeout Submittals: Project record documents, operation and maintenance data, warranties, and bonds.

J. Section 02 4100 - Demolition: Demolition of whole structures and parts thereof; site utility demolition.

K. Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations 2022.

1.04 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Survey work: Submit name, address, and telephone number of Surveyor before starting survey work.
   1. On request, submit documentation verifying accuracy of survey work.
   2. Submit a copy of site drawing signed by the Land Surveyor, that the elevations and locations of the work are in compliance with Contract Documents.
   3. Submit surveys and survey logs for the project record.

C. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
   1. Structural integrity of any element of Project.

2. Integrity of weather exposed or moisture resistant element.
3. Efficiency, maintenance, or safety of any operational element.
4. Visual qualities of sight exposed elements.
5. Work of Iowa Department of Transportation or separate Contractor.
6. Include in request:
    a. Identification of Project.
    b. Location and description of affected work.
    c. Necessity for cutting or alteration.
    d. Description of proposed work and products to be used.
    e. Effect on work of Iowa Department of Transportation or separate Contractor.
    f. Written permission of affected separate Contractor.
    g. Date and time work will be executed.

D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.05 QUALIFICATIONS

A. For field engineering, employ a professional engineer of the disciline required for specific service on Project, licensed in Des Moines, Iowa.

B. For surveying work, employ a land surveyor registered in IOWA and acceptable to IaDOT Project Manager. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,

1.06 PROJECT CONDITIONS

A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.

B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

C. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

D. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
    1. Provide dust-proof enclosures to prevent entry of dust generated outdoors.
    2. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Iowa Department of Transportation.

E. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
    1. Minimize amount of bare soil exposed at one time.
    2. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.

F. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.

G. Rodent Control: Provide methods, means, and facilities to prevent rodents from accessing or invading premises.

H. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.07 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Notify affected utility companies and comply with their requirements.

C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

F. Coordinate completion and clean-up of work of separate sections.

G. After Iowa Department of Transportation occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Iowa Department of Transportation's activities.

PART 2 PRODUCTS - NOT USED

2.01 PATCHING MATERIALS

A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 6000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

E. Verify that utility services are available, of the correct characteristics, and in the correct locations.

F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.

B. Require attendance of parties directly affecting, or affected by, work of the specific section.

C. Notify IaDOT Project Manager four days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of examination, preparation and installation procedures.
   2. Review coordination with related work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to IaDOT Project Manager, Iowa Department of Transportation, participants, and those affected by decisions made.

3.04 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.

B. Promptly notify IaDOT Project Manager of any discrepancies discovered.

C. Iowa Department of Transportation will locate and protect survey control and reference points.

D. Control datum for survey is that established by Iowa Department of Transportation provided survey.

E. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

F. Promptly report to IaDOT Project Manager the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

G. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to IaDOT Project Manager.

H. Utilize recognized engineering survey practices.

I. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
   1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
   2. Grid or axis for structures.
   3. Building foundation, column locations, ground floor elevations.

J. Periodically verify layouts by same means.

K. Maintain a complete and accurate log of control and survey work as it progresses.

L. On completion of foundation walls and major site improvements, prepare a certified survey illustrating dimensions, locations, angles, and elevations of construction and site work.

3.05 GENERAL INSTALLATION REQUIREMENTS

A. In addition to compliance with regulatory requirements, conduct construction operations in compliance with NFPA 241, including applicable recommendations in Appendix A.

B. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.

C. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

D. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

E. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

F. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. Perform whatever cutting and patching is necessary to:
   1. Complete the work.
   2. Fit products together to integrate with other work.
   3. Provide openings for penetration of mechanical, electrical, and other services.
   4. Match work that has been cut to adjacent work.
   5. Repair areas adjacent to cuts to required condition.
   6. Repair new work damaged by subsequent work.

7. Remove samples of installed work for testing when requested.
8. Remove and replace defective and non-complying work.

C. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.

D. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

E. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

F. Restore work with new products in accordance with requirements of Contract Documents.

G. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

H. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 8400, to full thickness of the penetrated element.

I. Patching:
1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
2. Match color, texture, and appearance.
3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.

3.07 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.08 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

G. Prohibit traffic from landscaped areas.

H. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.09 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

G. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.10 DEMONSTRATION AND INSTRUCTION

A. Demonstrate operation and maintenance of products to Iowa Department of Transportation's personnel two weeks prior to date of Substantial Completion.

B. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of Owner's personnel.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Iowa Department of Transportation's personnel in detail to explain all aspects of operation and maintenance.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

3.11 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

B. Testing, adjusting, and balancing HVAC systems: See Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.

3.12 FINAL CLEANING

A. Contractor will provide comprehensive cleaning after final acceptance.

B. Use cleaning materials that are nonhazardous.

C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.

D. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, and drainage systems.

E. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.13 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.
   1. Provide copies to IaDOT Project Manager and Iowa Department of Transportation.

B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.

C. Notify IaDOT Project Manager when work is considered ready for IaDOT Project Manager's Substantial Completion inspection.

D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for IaDOT Project Manager's Substantial Completion inspection.

E. Conduct Substantial Completion inspection and create Final Correction Punch List containing IaDOT Project Manager's and Contractor's comprehensive list of items identified to be completed or corrected and submit to IaDOT Project Manager.

F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Iowa Department of Transportation-occupied areas.

G. Accompany Project Coordinator on Contractor's preliminary final inspection.

H. Notify IaDOT Project Manager when work is considered finally complete and ready for IaDOT Project Manager's Substantial Completion final inspection.

I. Complete items of work determined by IaDOT Project Manager listed in executed Certificate of Substantial Completion.

J. Provide Commissioning Documents for HVAC system with Engineers seal and signature.

3.14 MAINTENANCE

A. Provide service and maintenance of components indicated in specification sections.

B. Maintenance Period: As indicated in specification sections or, if not indicated, not less than one year from the Date of Substantial Completion or the length of the specified warranty, whichever is longer.

C. Furnish service and maintenance of components indicated in specification sections during the warranty period.

D. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.

E. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.

F. Maintenance service shall not be assigned or transferred to any agent or subcontractor without prior written consent of the Iowa Department of Transportation.

G. 11 Month Inspection of Buildings and Property shall be done by Contractor and IDOT Representative. Any items that are covered by the one year warranty that are damaged or need replacement will need to be documented and provided to Contractor to be corrected as part of the

END OF SECTION

SECTION 01 7419
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
   1. Aluminum and plastic beverage containers.
   2. Corrugated cardboard.
   3. Wood pallets.
   4. Clean dimensional wood: May be used as blocking or furring.
   5. Land clearing debris, including brush, branches, logs, and stumps; see Section 31 1000 - Site Clearing for use options.
   6. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
   7. Gypsum drywall and plaster.
   8. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (http://flooring.dupont.com) and Interface (www.interfaceinc.com) conduct reclamation programs.
   9. Paint.
   10. Fluorescent lamps (light bulbs).

E. Contractor shall submit periodic Waste Disposal Reports; all landfill disposal, recycling, salvage, and reuse must be reported regardless of to whom the cost or savings accrues; use the same units of measure on all reports.

F. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.

G. The following sources may be useful in developing the Waste Management Plan:

H. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.
   5. Incineration, either on- or off-site.

I. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

RELATED REQUIREMENTS

J. Section 01 3000 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

K. Section 01 5000 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

L. Section 01 6000 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

M. Section 01 7000 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

N. Section 31 1000 - Site Clearing: Handling and disposal of land clearing debris.

1.02 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Waste Management Plan: Include the following information:

Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.

Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).

Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.

1. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
2. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
3. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated

centers, or whether mixed materials will be collected by a waste hauler.

4. Waste Disposal Reports: Submit at specified intervals, with details of quantities of trash and waste, means of disposal or reuse, and costs; show both totals to date and since last report.
    a. Submit updated Report with each Application for Progress Payment; failure to submit Report will delay payment.
    b. Submit Report on a form acceptable to Owner.
    c. Landfill Disposal: Include the following information:
        1) Identification of material.
        2) Amount, in tons or cubic yards, of trash/waste material from the project disposed of in landfills.
        3) State the identity of landfills, total amount of tipping fees paid to landfill, and total disposal cost.
        4) Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
    d. Recycled and Salvaged Materials: Include the following information for each:
        1) Identification of material, including those retrieved by installer for use on other projects.
        2) Amount, in tons or cubic yards, date removed from the project site, and receiving party.
        3) Transportation cost, amount paid or received for the material, and the net total cost or savings of salvage or recycling each material.
        4) Include manifests, weight tickets, receipts, and invoices as evidence of quantity and cost.
        5) Certification by receiving party that materials will not be disposed of in landfills or by incineration.
    e. Material Reused on Project: Include the following information for each:
        1) Identification of material and how it was used in the project.
        2) Amount, in tons or cubic yards.
        3) Include weight tickets as evidence of quantity.
    f. Other Disposal Methods: Include information similar to that described above, as appropriate to disposal method.

PART 2 PRODUCTS

2.01 PRODUCT SUBSTITUTIONS

A. See Section 01 6000 - Product Requirements for substitution submission procedures.

B. For each proposed product substitution, submit the following information in addition to requirements specified in Section 01 6000:
    1. Relative amount of waste produced, compared to specified product.
    2. Cost savings on waste disposal, compared to specified product, to be deducted from the Contract Sum.
    3. Proposed disposal method for waste product.
    4. Markets for recycled waste product.

PART 3 EXECUTION

WASTE MANAGEMENT PROCEDURES

See Section 01 3000 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

See Section 01 5000 for additional requirements related to trash/waste collection and removal facilities and services.

See Section 01 6000 for waste prevention requirements related to delivery, storage, and handling.

See Section 01 7000 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

3.01 WASTE MANAGEMENT PLAN IMPLEMENTATION

Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and laDOT Project Manager.

A. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

B. Meetings: Discuss trash/waste management goals and issues at project meetings.
   1. Prebid meeting.
   2. Preconstruction meeting.
   3. Regular job-site meetings.

C. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. Provide containers as required.
   2. Provide adequate space for pick-up and delivery and convenience to subcontractors.
   3. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

D. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

E. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

F. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

G. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

END OF SECTION

SECTION 01 7800
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Project Record Documents.

B. Operation and Maintenance Data.

C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Section 01 3000 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

B. Section 01 7000 - Execution and Closeout Requirements: Contract closeout procedures.

C. Individual Product Sections: Specific requirements for operation and maintenance data.

D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to IaDOT Project Manager with claim for final Application for Payment.

B. Operation and Maintenance Data:
   1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. IaDOT Project Manager 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 Iowa Department of Transportation, 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 IaDOT Project Manager 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 Iowa Department of Transportation'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

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.
   6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Iowa Department of Transportation.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish first floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

A. Source Data: 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.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. For Each Product, Applied Material, and Finish:
   1. Product data, with catalog number, size, composition, and color and texture designations.
   2. Information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional information as specified in individual product specification sections.

E. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

F. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

3.04 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. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

D. Include color coded wiring diagrams as installed.

E. 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.

F. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

G. Provide servicing and lubrication schedule, and list of lubricants required.

H. Include manufacturer's printed operation and maintenance instructions.

I. Include sequence of operation by controls manufacturer.

J. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

K. Provide control diagrams by controls manufacturer as installed.

L. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.

M. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

N. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

O. Include test and balancing reports.

P. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals for Iowa Department of Transportation's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

C. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

D. Prepare data in the form of an instructional manual/

E. 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.

1. The operation and maintenance Data documents can be submitted in a CD or Flash Drive but must be seperated on the electronic drive as follows:
    a. Data in PDF Format and named by Specification Number of Product or equipment.
    b. Data included in Folders by Specification Division Number.

F. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

G. Project Directory: Title and address of Project; names, addresses, and telephone numbers of IaDOT Project Manager, Consultants, Contractor and subcontractors, with names of responsible parties.

H. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in

each volume, with the current volume clearly identified.

I. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

J. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.

K. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

L. Arrange content by systems under section numbers and sequence of Table of Contents of this Project Manual.

M. 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 Architect, 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.
      f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
   3. Part 3: Project documents and certificates, including the following:
      a. Shop drawings and product data.
      b. Air and water balance reports.
      c. Certificates.
      d. Photocopies of warranties and bonds.

N. Provide a listing in Table of Contents for design data, with tabbed dividers and space for instertion of data.

O. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Architect, Consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

3.06 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Iowa Department of Transportation's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.

F. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.

G. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

H. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION

Project Manual

for

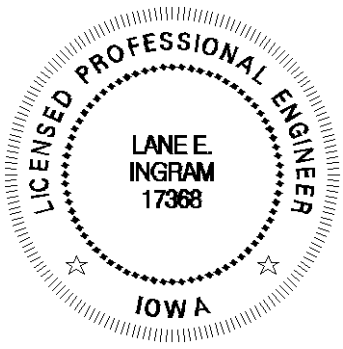
Avoca Electrical Upgrade
Work Order #30

Iowa Department of Transportation
Avoca, Iowa

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

Lane E. Ingram

_____ 04/15/2022__
(signature) (date)



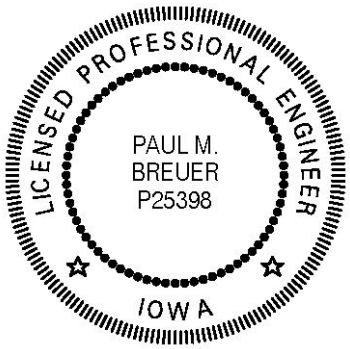
Discipline: Electrical Engineer, Iowa License No. 17368

License expires December 31, 2022.

Pages or sheets covered by this seal: Sections 26 05 00, 26 05 33, 26 05 43, 26 32 13-29, 26 36 23.

Stanley Consultants INC.
A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.



Paul M. Breuer

Paul M Breuer _____ 04/15/2022_

(signature) (date)

Discipline: Mechanical Engineer, Iowa License No. P25398

License expires December 31, 2022.

Pages or sheets covered by this seal: Sections 20 05 00, 20 05 13, 20 05 23.

AVOCA ELECTRICAL UPGRADE
WORK ORDER #30

IOWA DEPARTMENT OF TRANSPORTATION
AVOCA, IOWA

SPECIFICATIONS GROUP

FACILITY SERVICES SUBGROUP

PART 1 GENERAL

1.01 INFORMATIONAL SUBMITTALS

A. Quality assurance data: Certified records, indicating that procedures used and welding operators employed are in compliance with codes referenced in article "Quality Assurance."

1.02 QUALITY ASSURANCE

A. Certifications: New materials and equipment shall bear manufacturer's name, model number, or other identification marking.

B. Standard product shall be of latest design with published properties of manufacturer regularly engaged in production of specified material or equipment for minimum 5 years.

C. Unless otherwise indicated, equipment of same type in same room shall match color, finish, and design.

D. Standardization: Equipment and its devices shall be of same manufacturer; or devices must be approved and warranted by equipment manufacturer

E. Building codes and permits:
   1. Obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses.
   2. Pay governmental charges and inspection fees necessary for prosecution of Work, which are applicable at time of opening of Bids. Pay charges of utility service companies for connections to Work. Owner will pay charges of such companies for capital costs related thereto.
   3. Give notices and comply with laws, ordinances, building and construction codes, rules, and regulations applicable to Work. If Contractor observes Specifications or Drawings are at variance therewith, give Engineer prompt written notice thereof, and any necessary changes shall be adjusted by appropriate Modification.
   4. If Contractor performs any Work knowing or having reason to know that Work is contrary to such laws, ordinances, rules, and regulations, and without such notice to Engineer, Contractor shall bear all costs arising therefrom. However, it shall not be Contractor's primary responsibility to make certain that Specifications and Drawings are in accordance with such laws, ordinances, rules, and regulations.

1.03 COORDINATION

A. Coordinate with all trades regarding location and size of pipes, equipment, ducts, openings, light fixtures, and other similar items mutually located in same or adjacent spaces.

B. Drawings are diagrammatic; however items on Drawings are shown at approximate locations. Contractor shall modify locations of equipment, piping, ducts, etc to suit actual conditions, and provide for access and clearances.
   1. Route piping and ducts parallel to building lines, except for slope.
   2. Protection of electrical equipment: Avoid locating equipment, piping, ducts, etc, over electrical equipment. As approved by Owner, provide drip pans over electrical equipment where locating equipment, piping, ducts, etc. above electrical equipment is unavoidable.

C. Due to scale of Drawings, not all items are shown on drawings. Provide items not shown but required for complete operating systems.

D. Due to scale of Drawings, do not scale Drawings to determine exact locations. Locations shall be determined by field measurements or other means.

E. Make minor modifications in Work required by interferences (structural, work of other trades) following notification to Engineer.

PART 2 PRODUCTS

2.01 DESIGN REQUIREMENTS

A. Design is based on specified or scheduled equipment. Modify work to incorporate changes for alternate, “or equal”, or substitute manufacturer’s equipment at no additional cost.
   1. Changes shall included but not be limited to:
      a. Equipment dimensions.
      b. Framing and support.
      c. Manufacturer recommended maintenance clearances and access.
      d. Pipe connections, location and sizes.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Work provided shall be complete and operable, and shall include required accessories, specialties, fastenings, supports, auxiliary building steel, and similar items.

B. Determine required location, arrangement, and quantities of equipment and materials from Drawings.

C. Equipment shall be installed in accordance with manufacturers' recommendations.

END OF SECTION

1) P. M. Breuer
2) R. L. Lukkarinen

Stanley Consultants INC.

PIPE CLASS SPECIFICATION - ACS6

MAWP	TEMP, °F	100	200	300	353						
	PRESS, PSIG	150	135	110	100						

PIPE	MATERIAL, ASTM	A53 GR B TYPE E OR S (NOTE 6)			
	NOMINAL PIPE SIZES AND SCHEDULE	1/2" - 24"		STD	
JOINT	TYPE	THREADED	SOCKET WELD	BUTT WELD	FLANGED
	USE FOR PIPE SIZES	1/2" - 2"	NONE	2-1/2" - 24"	NONE
FITTINGS	MATERIAL, ASTM	A197		A234 WPB	
	PRESS CL, ASME B16.3	150			
	MINIMUM WALL THICKNESS			MATCH PIPE	
	WELDING END			ASME B16.25	
	UNIONS	GROUND JOINT		NONE	

FLANGES	MATERIAL, ASTM	A105
	PRESS CL, ASME B16.5	150
	FACING	FF SERRATED
	GASKETS, ASME B16.21	FULL FACE 1/16" SYNTHETIC FIBER WITH NBR BINDER, GARLOCK BLUE-GARD 3000 OR EQUAL, UNLESS SPECIFIED OTHERWISE. OTHERWISE.
	BOLTING	A307 GR B STUD BOLTS & A194 GR 2H HEX NUTS

GENERAL NOTES & COMMENTS:

1. BACKING RINGS NOT PERMITTED.
2. BUTT WELD END PREPARATIONS
   A. NOMINAL PIPE WALL THICKNESSES 0.375" AND LESS: CONFORM TO ASME B16.25, FIGURE 2, DETAIL (A).
3. BUTT WELD FITTINGS MAY BE WPB SEAMLESS OR WPBW WELDED.
4. FLANGE CONNECTIONS TO EQUIPMENT AND VALVES ONLY.
5. FLANGES SHALL BE WELD NECK OR SLIP-ON.
6. FOR HOT WATER SERVICE AT PRESSURES ABOVE 100 PSIG AND TEMPERATURES ABOVE 220 °F, THREADED PIPE SHALL BE SCHEDULE 80 SEAMLESS, A53 GR B OR A106 GR B.

NO.	REVISION	DATE	DESIGN	CHECK	APVD	
						ASME CLASS 125
						TYPE E OR S CARBON STEEL
1	GENERAL	1-Oct-08	DDB	MSW	MAE	NO.
0	REVISION 0	28-Apr-06	AGP	JJN	MAE	**ACS6**

M-1711

Stanley Consultants INC.

PIPE CLASS SPECIFICATION - APE4

MAWP	TEMP, □F	40	60	73	100	120	140				
	PRESS, PSIG	100	100	100	85	70	60				

PIPE	MATERIAL	PE4710, BLACK, HDB 1600 PSI (73□F), HDB 1000 PSI (140□F)				
	CELL CLASS	ASTM D3350 445574C				
	PIPE	ASTM D2513				
	NOMINAL PIPE SI E AND SDR	IPS 1/2" - 8"	11			

FITTINGS	T PE	ELECTROFUSION	SOCKET	BUTT	MECH (PLASTIC)	MECH (METALLIC)
	STANDARD	F1055	ASTM D2683	ASTM D3261	F1924	F1948
	USE FOR SI ES	1/2" - 8"	1/2" - 4"	1/2" - 8"	1/2" - 2"	1/2" - 8"

JOINT	T PE (NOTE 4)	SOCKET OR BUTT FUSION IN ACCORDANCE WITH ASTM F2620 AND MANUFACTURER'S STANDARD. FLANGE CONNECTIONS TO EQUIPMENT AND VALVES ONL IN ACCORDANCE WITH ASTM F2880.
FLANGES	T PE	MOLDED FROM SAME T PE POL ETH LENE MATERIAL AS PIPE AND FITTINGS WITH STEEL BACK-UP FLANGE CONFORMING TO ASME B16.5 150 LB FLANGE DIMENSIONS.
	BOLTING	ASME 150 LB DIMENSIONS, ASTM A307 BOLTS, STUDS AND HE HEAD NUTS. INSTALL WASHER UNDER BOLT HEADS AND NUTS.
	GASKETS	FULL FACE 1/8" S NTHETIC FIBER WITH NBR BINDER, GARLOCK BLUE-GARD 3000 OR EQUAL, UNLESS SPECIFIED OTHERWISE.

GENERAL NOTES COMMENTS:

1. INSTALL IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS AND PPI STANDARDS.
2. PRESSURE AND TEMPERATURE RATINGS ARE BASED ON DR NATURAL GAS SERVICE. FOR LIQUIFIED PETROLEUM GAS (LPG) VAPOR SERVICE, MAWP IS LIMITED TO 30 PSIG.
3. INSTALL IN ACCORDANCE WITH NFPA 54, NATIONAL FUEL GAS CODE AND NFPA 58, LIQUEFIED PETROLEUM GAS CODE AS APPLICABLE FOR SERVICE SPECIFIED.
4. THREADED OR MITER JOINTS NOT ALLOWED.
5. FOR BURIED OUTDOOR SERVICE ONL .
6. COMPONENTS AND INSTALLATION SHALL COMPL WITH DOT (CFR) TITLE 49, PART 192, AND/OR LOCAL CODES AS APPLICABLE.

NO.	REVISION	DATE	DESIGN	CHECK	APVD	
						100 PSI AT 73□F
						POL ETH LENE PIPE
1	GENERAL	31-Mar-17	JJO	JC	MAE	NO.
0	REVISION 0	28-Apr-06	AGP	JJB	MAE	**APE4**

M-1761

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe materials.

B. Fittings, unions, flanges, and couplings.

C. Welding fittings.

D. Piping identification.

E. Pipe coating and wrapping.

F. Tie rods.

G. Pipe joining methods.

H. Cleaning and protection.

I. Leakage tests.

J. Thrust restraints.

K. Piping schedules.

1.02 DEFINITIONS

A. Pipe Class Specifications define pipe materials, dimensional standards, and wall thickness. Also defined are other components of piping system, including fittings, joints, flanges, and connection methods as applicable. Maximum allowable working pressure and associated temperature are provided for reference. Some Pipe Class Specifications also include notes and comments that provide additional direction on use, limitations, and installation of piping system.

1.03 INFORMATIONAL SUBMITTALS

A. Quality assurance data:
   1. Certificates of compliance with standards specified for pipe, fittings, accessories, and specialties.
   2. Welding procedure specifications and welding operator performance qualifications in accordance with ASME “Boiler and Pressure Vessel Code”, Section IX, upon request.

1.04 QUALITY ASSURANCE

A. Regulatory requirements:
   1. Piping construction criteria shall conform to requirements of ASME B31 as applicable. Work shall also comply with applicable state and local codes.
   2. Piping connected to pressure parts under jurisdiction of ASME "Boiler and Pressure Vessel Code": In accordance with ASME "Boiler and Pressure Vessel Code" and state and local codes.
   3. Piping not covered by ASME "Boiler and Pressure Vessel Code": In accordance with ASME B31 "Code for Pressure Piping” and state and local codes.
   4. Comply with applicable requirements of state and local plumbing codes including but not limited to NSF 61 requirements for potable water piping and fittings.

B. Certifications: New materials and equipment shall bear manufacturer's name, model number, or other identification marking.

C. Pipe spools shall contain piece identification mark on each end of spool.

D. Piping material shall be new. Materials showing signs of scaling or rust will be rejected.

E. Welding requirements:
   1. Qualification of welding procedures to be used and welding operators shall be in accordance with ASME “Boiler and Pressure Vessel Code,” Section IX.
   2. Welding materials and procedures for piping shall conform to ASME B31 and applicable state and local regulations.
   3. Employ certified welders in accordance with ASME “Boiler and Pressure Vessel Code,” Section IX, and AWS D1.1.
   4. Welding inspection personnel shall be qualified in accordance with AWS QC1.
   5. Maintain records in accordance with requirements of ASME B31.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Weld end larger than 2” (50 mm): Fit pipe with protective end caps. Seal with waterproof tape.

B. Female opening 2” (50 mm) and smaller: Install plastic insert and seal with waterproof tape.

C. Nonflanged nipples 2” (50 mm) and smaller: Fit pipe with plastic cap and seal with waterproof tape.

D. Flanged opening: Bolt 1/2” (13 mm) waterproof disk with 1/8” (3 mm) rubber gasket. Use at least half available holes.

PART 2 PRODUCTS

2.01 DESIGN REQUIREMENTS

A. Pipe, fittings, valves, and accessory material shown on Drawings and as necessary for complete piping system with connections to equipment. Provide drains required to drain low points in piping and vents required to vent high points in piping. Provide piping for testing, startup, cleaning, and operation of system.

B. Provide pipe, fittings, valves, and accessory material necessary for following piping not shown on Drawings:
   1. Vents and drains for equipment to which piping connections are made or which are installed under this Contract. Provide piping to drains from equipment including, but not limited to, level alarms, meter bodies, transmitters, steam trap blow connections.
   2. Piping, not shown on Drawings, but required for proper operation of piping system and equipment, including drain valves required to drain all low points in piping and vent valves required to vent all high points in piping for testing, start-up, and operation.
   3. Metering instruments and regulating apparatus, including pressure gages, thermometers, controllers, traps, and other appurtenances as required for satisfactory operation of piping system and proper functioning of such instruments and controls.
   4. Flanges, unions, bolting material, gaskets, reducing fittings, bushings, and adapters required to connect piping to equipment, valves, in line specialties, etc.
   5. Temporary piping and accessories required for placing equipment and piping into initial service including, but not limited to, cleaning and hydrostatic testing. Arrangement of piping and supports shall be submitted to Owner for review.
   6. Blind flanges, caps, or plugs of appropriate class to close unused openings in equipment or piping provided by others.
   7. Flanges as required for connection to equipment by others.

C. Piping arrangement: Fire protection, plumbing and HVAC piping are generally schematically routed. Contractor shall vary location of piping and ducts to suit actual conditions, provide for access and clearances, and provide for thermal expansion. Field-fabricate and erect to provide workable arrangement with convenient access to valves and specialty items. Piping arrangement shall allow for thermal expansion and clearance after insulation is installed.

1. Route piping parallel to building lines, except for slope.
2. Protection of electrical equipment: Avoid locating pipe, joints, specialties, valves, etc. over electrical equipment to meet requirements of Article 110 of NEC. Provide drip pans over electrical equipment as approved by Owner where routing of piping over electrical equipment is unavoidable.
3. For equipment, valves, etc. with connections less than line size, locate reducers at equipment or valves to minimize length of reduced diameter piping.
4. Contractor shall note on record drawings modifications made to piping systems.

D. Provide pipe, fittings, accessories, and appurtenances required by each Pipe Class Specification.

E. Maintain a minimum of 3” (75 mm) clearance between pipes. For insulated piping, clearance shall be from outside surface of insulation.

2.02 PIPE MATERIALS

A. Pipe materials, pressure class, schedule, and type of joints shall conform to Pipe Class Specifications referenced in Pipe Schedule.

B. If pipe wall thickness specified is not available, use next heavier wall thickness.

C. Comply with ASME B31 and, where applicable, ASME “Boiler and Pressure Vessel Code.”

2.03 FITTINGS - GENERAL

A. Material, wall thickness, and pressure class: As specified in article "Pipe Materials," unless otherwise noted.

B. Use long radius fittings, except where noted on Drawings to use short radius fittings.

C. Provide dielectric unions or flanges at connections between ferrous and nonferrous piping or equipment.

D. For soil and waste piping, use 45° Y fittings and long sweep quarter, eighth or sixteenth bends.

2.04 UNIONS, FLANGES, AND COUPLINGS

A. Pressure class, material, and facing: As specified in article "Pipe Materials."

B. Where union, flanges, and couplings are not specified in Pipe Class Specification, provide as follows:
1. Pipe size 2" (50 mm) and smaller: Malleable iron unions for threaded ferrous piping; cast bronze or wrought copper unions for copper piping with soldered or brazed joints. For nonmetallic piping provide unions of same material as pipe.
2. Pipe size 2-1/2" (64 mm) and larger: Forged steel weld neck or slip-on flanges for ferrous piping; bronze flanges for copper piping. For non-metallic piping, provide flanges of same material as pipe. Provide 1/8" (3 mm) thick preformed synthetic fiber gaskets, Garlock "Blue-Gard 3000," or equal.
3. Grooved end pipe: Malleable iron housing clamps to engage and secure grooved pipe ends, designed to permit angular deflection, contraction, and expansion; C-shape composition sealing gasket, steel bolts, nuts, and washers; use galvanized couplings for galvanized pipe.

2.05 WELDING FITTINGS

A. Material and wall thickness: As specified in article "Pipe Materials."

B. Use welding tees for socket-welded piping and for field-fabricated branch tees in butt-welded piping.

C. Nozzle-welded branches or "Weldolets" and "Threadolets" will be permitted instead of butt welding tees for shop-fabricated steel piping provided that such nozzles are fabricated in accordance with ASME B31. Use tees for branches in non-steel piping.

D. Mitering of pipe to form elbows, notching straight pipe to form tees, and similar construction will not be acceptable for pressure piping except where specifically permitted in Pipe Class Specifications.

E. Steel bolts: ASTM A325.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install piping as shown on Drawings, as specified, and in accordance with manufacturer's recommendations. Hot and cold potable water piping and sanitary and storm drainage systems shall comply with state and local plumbing codes.

B. Modify pipe routing as required to clear building structure, openings, lights, ducts, and work of other trades.

C. Route piping parallel to building lines except for slope.

D. Provide sufficient unions and flanges to permit removal of equipment.

E. Spacing of piping shall be adequate to permit servicing valves and specialties and replacing sections of pipe.

F. Install piping above suspended ceiling areas to allow for suspended ceiling panel removal.

G. Slope pipe to permit complete draining. Install drain valves at low points.

H. Provide nuts, bolts, gaskets, and washers for complete and proper installation.

I. Warning tape shall be installed over each underground pipe. For underground non-metallic pipes, provide trace wire.

J. Furnish direct buried steel piping with renewable cathodic protection when indicated.

K. Install Double wall HDPE corrugated drain pipe, PVC perforated drain pipe, and ABS perforated drain pipe in accordance with ASTM D2321 and manufacturer's recommendations.

3.02 PROVISIONS FOR PIPE EXPANSION

A. Provide bends, offsets, or loops in piping not detailed on Drawings as required to permit pipe expansion due to temperature change and equipment movement.

B. Provide sufficient flexibility in copper piping to eliminate stress transmission to fixtures.

C. See Section 20 05 29 for additional pipe expansion and support requirements.

3.03 PIPE JOINING METHODS

A. Comply with Pipe Class Specifications listed under article "Pipe Materials" and with requirements of ASME B31, unless otherwise indicated.

B. Threaded joints:
   1. Clean-cut threads, ream pipe ends, and remove burrs.
   2. Apply suitable lubricating, noncorrosive, flexible pipe joint compound to male threads only.

C. Flanged joints:
   1. Clean mating surfaces of flanges.
   2. Install gasket and tighten bolts evenly.

D. Weld joints:
   1. Cut pipe square and prepare pipe ends for welding as required by ASME B31.
   2. Workmanship shall conform to details and requirements of ASME B31.

E. Other joints and joining methods: In accordance with Pipe Schedule and Pipe Class Specifications.

3.04 LEAKAGE TESTS

A. Notify Engineer and Owner of intent to test piping at least 1 week prior to test. Test in presence of Engineer and Owner, unless notified otherwise.

B. Other piping: Test hydrostatically in accordance with ASME B31.

C. Provide pumps, compressors, meters, gages, piping, fittings, accessories, and labor required to conduct tests.

D. Isolate equipment that may be damaged by test pressure.

E. Refit joints indicating leakage and replace defective pipe, fittings, and accessories.

3.05 CLEANING AND PROTECTION

A. Remove foreign material from pipes before erection.

B. Close ends of partially erected systems.

C. Remove temporary preservative coatings from valves and accessories.

D. Flush or otherwise clean systems after erection.

E. Prior to conducting final performance test, Contractor shall verify that strainers are clean.

F. Contractor shall be responsible for malfunctioning of pumps, valves, controls, or other equipment due to presence of foreign material. Clean, repair or replace malfunctioning equipment at no cost to Owner.

G. Disinfect potable water piping as required by health authority having jurisdiction.

H. Thoroughly flush lines after disinfection until extremities indicate same chlorine residual as supply water.

3.06 PIPE IDENTIFICATION

A. Provide pipe markers on new piping exposed in equipment rooms, accessible pipe shafts, unfinished basement areas, unfinished storage rooms, janitor's closets, tunnels, and other areas where directed.

B. Install markers on both horizontal and vertical section of pipe at points where pipes pass through walls, floor, or ceiling, and at each valve. In tunnels, markers shall be no greater than 20' (6 m) apart, or 1 marker minimum for sections less than 20' (6 m).

3.07 THRUST RESTRAINTS

A. Required for unrestrained buried pressure piping at change of direction.

B. Install thrust blocks or approved restraints in accordance with requires of NFPA 24.

3.08 PIPE SCHEDULE

Service	Pipe Description	Piping Class Specification [1]	Design Temp. (°F)	Operating Temp. (°F)	Design Pressure (psig)	Operating Pressure (psig)	Test Pressure (psig)	Testing Method [2]
Natural Gas and Propane								
	ASTM A53 Gr. B Steel	ACS6						
Natural Gas and Propane (Buried Exterior)								
	ASTM D2513 PE3408	APE4						

Notes:
[1] Where multiple Pipe Class Specifications are specified, selection of material is at Contractor's option.
[2] Testing in accordance with ASME B31 unless noted otherwise.

END OF SECTION

1) P. M. Breuer
2) R. L. Lukkarinen

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Valves shown on Drawings, mechanical standards, mechanical details, and valve schedule.

B. Valves not shown on Drawings including:
1. Vent and drain valves for equipment installed under this Contract.
2. Piping high-point vents and low-point drains.
3. Connections to metering instruments and controls including pressure gages, transmitters, controllers, traps, and appurtenances required for proper functioning of instruments and controls.
4. Temporary valves and accessories required for placing equipment into initial service.
5. Valves inherent to operation or protection of equipment installed under this Contract.
6. Plumbing isolation valves for each restroom group.

C. Accessories.

1.02 ACTION SUBMITTALS

A. Shop Drawings:
1. Certified drawings for each type and size of valve. As a minimum, Drawings shall contain:
a. Valve tag numbers (if shown on drawings).
b. Materials of construction.
c. Valve end-to-end and envelope dimensions with operators.
d. Valve weight including operator if applicable.
e. Weld end preparation details.
f. Operator information.
g. Special features such as vacuum service, locking device, limit switches, etc.
h. Design conditions.
2. Wiring diagrams for field installation of components.

1.03 QUALITY ASSURANCE

A. Valves shall be of same manufacturer for each class of piping and insofar as practicable for entire Project.

B. Design and construct Steel and iron valves in accordance with ASME B16.10 and ASME B16.34.

C. Valves in potable water service shall comply with applicable requirements of state and local plumbing codes including, but not limited to, NSF 61 requirements.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Preparation for shipment:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Storage precautions:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off ground in watertight enclosures.
3. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide specified manufacturer when indicated in Valve Schedule. Substitutions not allowed.

2.02 DESIGN CRITERIA

A. Valve schedule contains requirements for valves.

B. Pressure class ratings shown in valve schedule are anticipated pressure classes only. Lower intermediate pressure class or special pressure class valves are acceptable provided their ratings meet or exceed design pressure and design temperature of system as specified in Valve Schedule.

C. Verify that valves meet or exceed design pressure and design temperature specified in Valve Schedule.

D. Provide high-point vent valves and low-point drain valves not shown on Drawings. Conform to following table unless indicated otherwise on Drawings. Automatic vents and manual vents as specified in section.

Service	Pipe Size	Vent/Drain Size
Vents	1/2” and smaller	Line size
Vents	3/4” and larger	3/4”
Drains	1/2” and smaller	Line size
Drains	3/4” to 2”	3/4”
Drains	2-1/2” to 4”	1”
Drains	6’’ to 10”	1-1/2”
Drains	12” and larger	2”

E. Valve body materials shall be equivalent to piping material, unless noted otherwise.

Piping Material	Valve Body Material
Carbon steel	ASTM A105, ASTM A216 Grade WCB or ASTM A216 Grade WCC
1-1/4 chromium-molybdenum	ASTM A182 Grade F11
2-1/4 chromium-molybdenum	ASTM A182 Grade F22 or ASTM A217 Grade WC9
9 chromium-molybdenum	ASTM A182 Grade F9 or ASTM A217 Grade C12
Stainless steel Type 304 or 304L	ASTM A182 Grade F304 or F304L or ASTM A351 Grade CF3 or Grade CF8
Stainless steel Type 316 or 316L	ASTM A182 Grade F316 or F316L. Grade CF3M or Grade CF8M
Copper ASTM B88 Type K	Bronze ASTM B584-C84400, or equivalent
CPVC F441	CPVC ASTM D1784 Cell Classification 23447
PVC ASTM D1785	PCV ASTM D1784 Cell Classification 12454
Ductile iron	ASTM A126 B cast iron, ASTM A395 or ASTM A536 ductile iron

F. Valve end preparations:
1. Butt weld ends:
   a. Nominal pipe wall thickness 0.375” (10 mm) and less: ASME B16.25, Figure 2, Detail (a).
   b. Nominal pipe wall thickness greater than 0.375” (10 mm): ASME B16.25, Figure 5 or 6.
2. Socket weld ends: ASME B16.11.
3. Threaded joints: ASME B16.3 or ASME B16.11 as applicable.
4. Grooved ends: AWWA C606.
5. Solder joints: ASME B16.18.
6. Flanged ends: ASME B16.1, ASME B16.5, ASME B16.47 or AWWA C207, as applicable.

G. Valve ends: In accordance with Data Sheets unless noted otherwise.

H. Valves shall be suitable for operator mounting (handwheel, bevel gear, motor operator, air actuator) with valve in any position without external support.

I. Check valves shall be suitable for operation in horizontal and vertical flow up piping arrangements.

2.03 PLUG VALVES

A. Service: Natural gas.
1. Type: Lubricated plug, wrench-operated.
2. Size and connection: 1/2" (15 mm) through 3" (80 mm) threaded.
3. Body and plug: ASTM A126 Grade B, semisteel.
4. Supply each valve with wrench operator with set screw.
5. Baseplate springs: Stainless steel.
6. Lubricant: Suitable for natural gas service up to 250°F (121°C).
7. Working pressure: 200 psig (1380 kPa).
8. Manufacturer: Norstrom Model 114, or equal.

2.04 VALVE IDENTIFICATION

A. Valve shall be given unique tag numbers. Coordinate valve numbering system with Owner.

B. Each valve shall have stamped stainless steel tag bearing valve tag number securely fastened to valve with 20-gage (0.9 mm) stainless steel wire.

C. When multiple, identical small-bore valves (less than 2-1/2” [64 mm]) are shipped in bulk, tags may be field installed. Other tags shall be factory installed.

2.05 ACCESSORIES

A. Hand wheels and levers:
1. Provide unless noted otherwise. Levers shall be multi-position with positive locking device.
2. Valves installed in areas inaccessible to platforms shall be provided with chain wheels. Provide chain wheel operators for manual valves with hand wheel operators in horizontal plane located more than 6’-6” (2 m) above floor, unless noted otherwise. Provide sufficient chain to bring operation down to 6’-6” (2 m) above floor.
3. Hand wheels shall not exceed 24” (600 mm) diameter unless noted otherwise.

B. Locking devices:
1. Provide where valve is specified as “LO” or “LC” on Drawings or in Valve Schedule.
2. Allow for locking in closed or open positions with standard chain and padlock.
3. Owner will furnish padlocks.

2.06 SOURCE QUALITY CONTROL

A. Hydrostatic tests:
1. Subject valve to hydrostatic shell and seat leakage tests in accordance with MSS SP-61 for isolation valves, ASME B16.34 for isolation valves, and FCI 70-2 for control valves.
2. Maximum seat leakage during closure tests shall not exceed following ml/h per inch (25 mm) of nominal valve size:
a. Gates and globe: 10.
b. Check valves: 40.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves in accordance with manufacturer's recommendations and Section 20 05 13.

B. Install valves with stems horizontal or in upright position unless shown otherwise on Drawings.

C. Install globe valves with flow direction from below to above seat.

D. Tighten valve glands as work is erected and add additional gland packing if required. Retighten glands after valves are placed in operation and brought up to operating pressure and temperature.

E. Replace valve gland packing of valves installed by this Contract which is determined to be in unsatisfactory condition.

3.02 FIELD QUALITY CONTROL

A. Hydrostatic tests: Valve shall be suitable for field hydrostatic pressure tests in closed position of 1.5 times design pressure of system.

B. Radiographic examination: Perform as required by code. Special class and intermediate class valves shall be radiographically tested in accordance with ASME B16.34.

3.03 VALVE SCHEDULE

VALVE SCHEDULE

SERVICE	VALVE TYPE	DATA SHEET
Natural Gas and Propane 1/2" thru 4"	Ball or Plug	DS-4 or paragraph this section

BRONZE AND IRON VALVES		DATA SHEET - DS-4		
		Gate, Globe, and Checks		Ball
Size		2” (50 mm) and Less	2-1/2” (65 mm) and Larger	4" (100 mm) and Less
Pressure class		150 psig (1035 k Pa g)at 220°F (104°C)	125 psig at 220°F (104°C)	125 psig (860 k Pa g)
MATERIALS	Body	Bronze	ASTM A126 Class B Cast Iron	Bronze
	Ball	n/a	n/a	Bronze
	Gate valve wedge	Bronze	Cast iron with bronze face rings	n/a
	Globe valve disc	TFE	Renewable Bronze	n/a
	Check valve disc	Bronze	Ductile Iron	n/a
	Stems	Silicon Brass	ASTM B16 Brass	Bronze
	Seats and Seals	Steam service- TFE Water, oil, gas- Buna-N	Bronze, ASTM B61	RPTFE
	Internals	Bronze	Renewable Bronze	
CONSTRUCTION	Stem	Inside screw with rising stem	Outside screw and yoke with Rising Stem	Blowout proof
	Packing	Aramid fibers with graphite	Aramid fibers with graphite	PTFE
	Bore Size	Full	Full	Full
	Ball valve body	n/a	n/a	2 piece
	Valve end type	Threaded, unless noted otherwise	Flanged, unless noted otherwise	Pipe Material: Copper, Steel End Type: Solder, Threaded
Manufacturer		Nibco, Watts, Crane	Nibco, Watts, Crane	Nibco, Watts, Apollo

END OF SECTION

1) P. M. Breuer
2) R. L. Lukkarinen

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General electrical requirements for equipment and services including, but not limited to:
1. Factory wiring.
2. Low voltage field wiring.
3. Low voltage splices and terminations.
4. Low voltage cabinets and electrical enclosures.
5. Equipment safety grounding.
6. Low voltage fuses and fuse blocks.
7. Electrical meters.
8. Control relays and switches.
9. Pushbuttons.
10. Indicating lights.
11. Alarm and trip contacts.
12. Low voltage starters.
13. Low voltage circuit breakers and disconnect switches.
14. Auxiliary power transformers.
15. Power factor correction capacitors.
16. Outlet, pull, and junction boxes.
17. Plates and covers.
18. Wiring devices,
19. Welding receptacles.
20. Panelboards.
21. Welding.
22. Shop finish.
23. Rust-inhibiting compounds.
24. Galvanizing.
25. Packaging, identification, and tagging.
26. Nameplates.
27. Trip setting coordination.
28. Grounding and bonding.
29. Fireproofing and fire ratings.
30. Testing and demonstration.

1.02 INFORMATIONALSUBMITTALS

A. Submit with Bid: Description of manufacturer’s standard factory test procedure for logic systems.

B. Product Data:
1. List of proposed material identifying manufacturer, type, and model number for equipment to be provided for complete job.
2. Manufacturer’s catalog sheets marked to indicate specific type, model, or catalog number of equipment to be provided.
3. Equipment drawings, elementary diagrams, schematics, wiring, performance curves, instruction manuals, and all other documentation necessary for complete description of material being supplied and as required to support installation, commissioning, and maintenance of equipment. Manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted.
4. Manufacturer’s technical descriptions, product data sheets, and applicable manuals for use in protective device system coordination including:
a. Fuse manufacturer, type, ratings, and protection curves.
b. Circuit breaker manufacturer, type, trip setting ranges, and protection curves.
c. Relay trip device ranges, curves, and setting manuals.
d. Transformer damage curves.
e. CT ratios and saturation curves.
f. VT ratings.

5. List of recommended spare parts required for equipment start-up, commissioning, and operation.
6. List of special maintenance tools required for installation and operation of equipment.
7. If necessary, provide additional data to clearly demonstrate that proposed alternate equipment meets or exceeds equipment as specified.
8. When requested by Engineer, submit system information, including but not limited to, utility feeders, existing relays, circuit breakers, fuses, and transformers.

1.03 CLOSEOUT SUBMITTALS

A. Operation and maintenance manuals. Provide at minimum:
1. Itemized equipment list.
2. General description and technical data.
3. Receiving, storage, installation, and testing instructions.
4. Operating and maintenance procedures.
5. Complete set of final drawings requiring no further action.
6. Complete documentation of inspections and tests performed, including logs, curves, and certificates. Documentation shall note any replacement of equipment or components that failed during testing.
7. Spare parts list.
8. Lubrication recommendations.
9. Warranty information.

1.04 MAINTENANCE MATERIALS

A. Extra materials: Provide touchup paint in same type and color to repair at least 25% of finish-painted equipment surface. Paint shall be sufficient to perform touch-up painting in accordance with shop-applied material instructions for repair painting.

B. Each piece of equipment shall be furnished with special tools as required for installation, maintenance, and dismantling of equipment.
1. Furnish in quantities as necessary to complete work on schedule.
2. Tools shall be new and shall become property of Owner.
3. Tools and intended use shall be identified in assembly instructions. Tools shall only be used for their intended purpose.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
1. Manufacturer of equipment specified shall be recognized in industry for normally supplying this type of equipment.
2. Manufacturer shall be ISO certified.
3. When requested by Engineer, provide list of similar equipment installations that have employed identical equipment from manufacturer.

B. Installer qualifications:
1. Installer shall be skilled in trade and shall have thorough knowledge of products and equipment specified.
2. Cutting, drilling, trenching, or channeling necessary to properly install equipment shall be performed by competent skilled crafts people in safe, professional manner.

C. Regulatory requirements: Perform electrical construction in accordance with NEC, local and state codes as applicable to job site.

D. Materials and equipment furnished for permanent installation shall be new, unused, and undamaged.

E. Asbestos not allowed.

F. Parts shall be manufactured to American industry standard sizes and gages to facilitate maintenance and interchangeability. Metric sized components not allowed unless specifically requested and approved.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Pack, ship, handle, and store in accordance with manufacturer's requirements.

B. Ship equipment completely factory assembled unless physical size, arrangement, configuration, or shipping and handling limitations make this impracticable. Shipping splits and required field assembly shall be identified with equipment submittals.

C. Costs associated with sections, accessories, or appurtenances requiring field assembly shall be Contractor's responsibility.

D. Separately packaged parts and accessories shall be consolidated and shipped together with equipment. Mark each container clearly to identify contents and as belonging with main equipment.
1. Provide individual weatherproof itemized packing slips attached to outside of each container for contents included. Provide duplicate inside each container.
2. Attach master packing list, covering accessory items for equipment, to main piece of equipment.
3. Mark each container with project identification number for equipment and container number followed by total number of containers.

E. Equipment shall be suitably protected during shipment, handling, and storage. Damage incurred during shipment shall be repaired at no cost to Owner.

F. Protect coated surfaces against impact, abrasion, and discoloration.

G. Electrical equipment and insulation systems shall be protected against ingress of moisture. Use space heaters if necessary to protect against moisture.

H. Exposed threads shall be greased and protected.

I. Pipe, tube, and conduit connections shall be closed with rough usage plugs. Seal and tape open ends of piping, tubing, and conduit.

J. Equipment openings shall have covers and taped to seal equipment.

K. Store materials in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

1.07 SCHEDULING

A. Coordinate with Owner early and late shipping and delivery schedules for items requiring storage and handling at Site.

1.08 WARRANTY

A. Electrical equipment shall be provided with manufacturer's standard warranty, but not less than 1 year.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

A. Service conditions: Provide equipment and material suitable for intended service and installation at location indicated.

B. Low-voltage auxiliary and control power.
   1. Electrical power for ac control and instrumentation equipment:
      a. Provide devices necessary for proper operation and protection of equipment during electrical power supply and ambient temperature fluctuations specified.
      b. Design for continuous operation at any voltage from 85% to 110% of nominal voltage. Dropout voltage shall be 60% of nominal for relays and 75% for contactors and starters.
   2. Electrical power for dc devices:
      a. Design for continuous operation on ungrounded station battery system, capable of maintaining operation at any voltage from 80% to 112% of nominal voltage.
      b. Electrical devices served shall not impose ground connection on supply.

C. Auxiliary power: Design auxiliary equipment for low voltage service, with electrical power designed to operate from one of nominal electrical power sources as follows and as indicated on Drawings:

Volts	Phase	Frequency
120/240	1	60

2.02 FACTORY WIRING

A. Select cable for electrical and environmental conditions of installation, and suitable for unusual service conditions where encountered.
   1. Proper temperature application cable shall be used throughout but shall be not less than 90ºC rated.
   2. Conductors routed over hinges shall use extra-flexible stranding.
   3. Cable insulation shall be rated for maximum service voltage used, but not less than 600 volts.
   4. Splices not allowed.

B. Panel, control cabinet, switchboard, motor control center, and switchgear wiring shall use flame retardant cross-linked polyethylene (XLP) or flame retardant ethylene-propylene rubber (EPR) insulation that meet or exceed requirements of UL 44 for Types SIS, and XHHW.
   1. Minimum size: No. 14 AWG (1.5 mm^2).
   2. Conductors: Annealed bare copper with fine stranding passing IEEE 1202 and UL VW-1 flame test.

C. Terminations:
   1. Conductor terminal connectors shall be insulated, ring tongue, compression type connectors properly sized for conductor and terminal.
      a. Connectors shall be constructed of copper and shall be tin-plated.
      b. Interior surface of connector wire barrel shall be serrated; exterior surface of connector wire barrel shall be furnished with crimp guides.
   2. Uninsulated terminal connectors shall be used for conductors terminated on devices equipped with individual fitted covers, such as, but not limited to, control switches and lockout relays.
   3. Connections requiring disconnect plug and receptacle type devices shall be provided with factory-terminated conductors on each plug and receptacle.
      a. Plugs and receptacles shall be factory wired into junction boxes containing terminal blocks for external connections.
      b. Conductors on disconnect portion of plug-receptacle assemblies shall be in common jacket.
   4. Prior to shipment of equipment, remove temporary wiring installed in factory for equipment testing.
   5. Current transformers shall terminate on shorting type terminal blocks. Ship with shorting jumpers installed.

D. Identification and labeling:
   1. Provide conductor identification sleeve on each end of each internal conductor. Mark each sleeve with opposite end destination identification with nonsmudging, permanent black ink. Sleeves shall be UV-resistant self-adhesive type or PVC, not less than 1/2” long.
   2. Permanently label each terminal block, terminal, conductor, relay, breaker, fuse block, and other auxiliary devices to coincide with identification indicated on manufacturer’s drawings.

2.03 FIELD WIRING

A. Nationally or internationally recognized cable manufacturer shall produce cable provided.
   1. Metal-clad cable, NEC Type MC, may not be substituted in place of cable and conduit unless specified otherwise, or unless approved in writing.
   2. Comply with code and Project requirements directly associated with use of each cable type.

B. Cables specified are for voltages 600 volts and below.

C. Wiring shall be annealed, bare copper with not less than 98% conductivity, unless specified otherwise.

D. General-purpose building conductor used on interior lighting circuits and general-purpose branch circuits routed entirely in conduit shall be single conductor.
   1. Voltage rating: 600-volt.
   2. Conductor: Class B, solid or stranded, annealed, uncoated copper, minimum size No. 12 AWG ($4.0mm^2$).
   3. Insulation: Polyvinyl chloride (PVC) complying with NEC for type THHN or THWN.
   4. Jacket: Overall clear nylon jacket applied over conductor insulation, UL-listed as gasoline and oil resistant.
   5. Cables shall pass IEEE 383 70,000 Btu/hr, UL Standard 83 for Type THHN or THWN wire.
   6. Color coding:
      a. Provide conductor sizes No. 8 AWG and smaller in following colors:
         1) Source voltage of 120/240 volts:
            a) Phase A: Black.
            b) Phase B: Red.
            c) Neutral: White.
      b. Sizes No. 6 AWG and larger shall be black and color-coded with field-applied tape.
   7. Installations in dry or damp locations shall utilize THHN and installations in wet locations shall utilize THWN.

E. Single-conductor, low-voltage power cable for motors, feeders, branch circuits, and dc circuits routed in conduit, duct bank, or cable tray:
   1. Voltage rating: 600-volt.
   2. Conductor: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG ($4.0mm^2$).
   3. Insulation: Cross-linked polyethylene (XLPE), complying with NEC Type XHHW-2. Insulation shall be sunlight resistant and cable tray (CT) rated.
   4. Jacket: None.
   5. Color coding: Black.
   6. Wire shall be identified by surface marking indicating manufacturer, conductor size, conductor material, voltage rating, UL symbol, and listed type.
   7. Cables shall pass IEEE 383 70,000 Btu/hr, ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and UL 1581, VW-1 vertical flame test.
   8. Temperature rating: 90^{o} C for normal operation in wet or dry locations.

F. Multiconductor, low-voltage power cables for motors, feeders, and branch circuits routed in cable tray, conduit or duct bank:
   1. Voltage rating: 600-volt.
   2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG ($4.0mm^2$).
   3. Insulation: Cross-linked polyethylene (XLPE) complying with NEC Type XHHW-2.
   4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; polyvinyl chloride (PVC).
   5. Color coding: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing as suitable for cable tray use.
   6. Phase conductors shall be cabled together with Class B stranded, bare copper grounding conductor and fillers. Ground wire size shall comply with requirements of UL 1277.
   7. Cover cable assembly with helically applied polyester binder tape with minimum 10% overlap.

8. Cables shall pass IEEE 383 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame test.
9. Temperature rating: 90° C for normal operation in wet or dry locations.

G. Multiconductor, low-voltage power cables for motors fed from adjustable speed drives, any installation.
1. Voltage rating: 600-volt.
2. Conductors: Annealed, bare copper, Class B, stranded, minimum size No. 12 AWG (4.0mm^2)
3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) complying with physical and electrical requirements for NEC Type XHHW-2.
4. Jacket: Flame-retardant, polyvinyl chloride (PVC).
5. Armor/shield: Continuously welded and corrugated high conductivity aluminum.
6. Ground conductors: 3 segmented Class B strand, annealed copper conductors sized to meet requirements of UL 1569.
7. Marking: Insulated phase conductors shall be black and shall have printed numbers in accordance with ICEA Method 4. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, metal, voltage rating, and UL listing.
8. Cables shall pass IEEE 1202 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests, and individual conductors UL-approved and marked with FT-4 designation.
9. Rated for Class 1, Div 1 hazardous locations.
10. Temperature rating: 90°C maximum continuous operating temperature in wet or dry locations.

H. Multiconductor cable for control, interlocks, current transformers (CTs), voltage transformers (VTs), routed in cable tray and conduit:
1. Voltage rating: 600-volt.
2. Conductors: Annealed, bare copper, Class B, stranded, CT minimum size No. 10 AWG (6.0mm^2), VT minimum size No. 12 AWG (4.0mm^2).
3. Insulation: Flame-retardant, cross-linked polyethylene (XLPE) or complying with NEC Type XHHW-2.
4. Jacket: Flame-retardant, heat, moisture, and sunlight-resistant; polyvinyl chloride (PVC).
5. Conductors shall be cabled together with nonhygroscopic fillers.
6. Cover cable assembly with helically applied binding tape with minimum 10% overlap.
7. Color coding: Insulated conductors shall have colored insulation meeting ICEA Method 1, Table E-2 color code (K2 color code).
8. Each cable shall be identified by means of surface ink printing indicating manufacturer, number of conductors, size, voltage rating, and UL listing as rated for cable tray.
9. Cables shall pass IEEE 383 70,000 Btu/hr, and ICEA T-29-520, 210,000 Btu/hr vertical tray flame tests.
10. Temperature rating: 90° C for normal operation in wet or dry locations.

I. Uninsulated and Insulated grounding conductors:
1. Voltage rating: 600V, green XHHW-2, when insulated.
2. Conductors: Class B, stranded, bare copper.

2.04 SPLICES AND TERMINATIONS

A. Splices, except as in lighting and general purpose power circuits specified below, not allowed unless specifically indicated on Drawings or required for connection to equipment.

B. Temperature rating of splices and terminations: No less than 75°C.

C. Splices allowed in lighting and general-purpose power circuits.
1. Provide wire and cable connectors of high-conductivity, corrosion-resistant material with contact area equal to at least current carrying capacity of wire or cable.
2. General lighting and general-purpose building power circuits:
a. Twist-type, insulated spring connectors for splices on solid or stranded conductors smaller than No. 6 AWG.

b. Use indent, hex screw, or bolt clamp-type connectors, with or without tongue for splices on solid or stranded conductors No. 6 AWG and larger.
c. Apply insulating 600-volt tape.

D. Insulating tapes and compounds for terminations and splices: UL-listed for intended use, location, and voltage by manufacturer.

E. Termination of conductors to equipment with bolted connections:
1. Use compression type lugs:
2. Compression lugs for cables 250 kcmil and larger shall have at least 2 clamping elements of compression indents, and provision for at least 2 bolts for joining to apparatus terminals.
3. Crimping hand tools used for securing conductors in compression type connectors or terminal lugs shall be made for purpose and conductor sizes involved.
4. Crimping tools shall be ratchet-type preventing tool from opening until crimp action is completed.
5. Tools shall be product approved by connector manufacturer.

F. Terminals:
1. Conductors No. 10 AWG and smaller: Marathon 1500 Series.
2. Conductors larger than No. 4/0 AWG: Terminate to tinned copper bus bar drilled and tapped with standard NEMA sized and spaced holes.

G. Coordinate sizes and types of conductor terminals for 600-volt power cable terminations in equipment with furnished conductor and terminal connector data.

H. Provide 600-volt rated terminal blocks for instrumentation and control conductors for connection to circuits external to specified equipment, and for internal circuits crossing shipping splits.
1. Use crimp-on terminals matching termination point terminations in manufacturer-furnished panels. Splices not allowed.
2. Terminal blocks for thermocouple extension wire: Buchanan “Medium Duty” with thermocouple contacts or Marathon 200 Series with Omega Engineering, Inc. Type TL terminal lugs.
3. Furnish with white marking strips.
4. Where permitted by safety codes and standards, provide without covers. Neither step-type terminal blocks nor angle mounting of terminal blocks allowed.
5. Fuses may be mounted on terminal blocks.
6. Maximum 2 conductors in accordance with termination point.

I. Terminal blocks for external connections shall leave from centrally mounted location, not from individual devices in enclosure.
1. Group-in instrument and control compartment for easy accessibility.
2. Provide sufficient space on each side of each terminal block to allow orderly arrangement of leads to be terminated on block.
3. Locate auxiliary equipment in compartments, enclosures, or junction boxes so service personnel will have direct access without interference from structural members and instruments without removal of barriers, cover plates, or wiring.
4. Do not mount terminal blocks in compartments containing cables or buses operating at voltages above 600 volts.
5. Size for wire sizes of incoming conductors as necessary.

J. Install shorting-type terminal blocks nearest current transformer in accessible location for each set of CTs supplied with equipment furnished, no other shorting-type terminal blocks allowed, unless specified otherwise.

K. Install din-rail mounted miniature circuit breakers (MCB) for protection of VT circuits on line and load side. Breakers shall have alarm contacts wired to terminal blocks.

L. Terminate each conductor in multiconductor control cable or as shown on Drawings. Provide 10% spare terminals for circuit modifications.

M. Each control switch and lockout relay shall have minimum of 4 spare normally open and 4 spare normally closed contacts wired out to terminal blocks.

N. Circuit identification number listed on either circuit schedule or panel schedule shall be used to identify circuit, positioned as near as possible to end of each conductor on multiple single wire circuits and on cable jacket for multiconductor cables.

O. Cable designations shall be visible after installation without requiring physical movement of cable.

2.05 ELECTRICAL ENCLOSURES

A. Size junction boxes, pull boxes, and enclosures in accordance with requirements of NEC.

B. Junction boxes and pull boxes 4” (100 mm) trade size or smaller in any dimension shall be galvanized malleable iron, or cast ferrous metal NEMA rated for installed location. Do not use concentric knockouts.

C. Junction boxes, pull boxes, and electrical enclosures larger than 4” (100 mm) trade size in any dimension shall be as follows, unless required otherwise.
   1. NEMA rating for electrical enclosures installed in nonhazardous locations:
      a. Indoor:
         1) Dry environmentally controlled area: NEMA 12.
         2) Noncorrosive wet or hose-down area: NEMA 4.
         3) Corrosive wet or hose-down area: NEMA 4X
      b. Outdoor:
         1) Corrosive area: NEMA 4X.
         2) Noncorrosive area hose-down or spray area: NEMA 4.
         3) Noncorrosive area nonhose-down area NEMA 3R.
   2. Construct noncast-metal electrical enclosures from reinforced steel plate capable of supporting devices mounted on or within enclosure without deflection. Steel plate thickness shall conform to UL requirements.
   3. Enclosures shall be of adequate strength to support mounted components during shipment and installation.
   4. Conduit entrances: Field drilled.
   5. Electrical enclosures located in outdoor, wet, or hose down areas shall be provided with space heaters. Provide space heaters completely wired within enclosure. Provide following:
      a. Space heater.
      b. Adjustable thermostat with set point temperature indicator.
      c. One miniature circuit breaker protective device.
      d. Space heaters, thermostat, and protection shall not interfere with cable into or out of enclosure, or with maintenance or replacement of devices within enclosure.
      e. Use of space heaters shall not change or discolor any painted surface.
      f. Space heater capacity shall maintain enclosure internal temperature above dew point under specified service conditions.
      g. Space heaters: Rate for 240 volts ac minimum, and size for operation on applied voltage of 120 volts ac.

D. Outdoor electrical enclosures with ventilating openings:
   1. Louver on outdoor electrical equipment and protect in accordance with NEMA type.
   2. Equip openings on outdoor electrical equipment with fine mesh filters and stainless steel bug screens.

2.06 OUTLET BOXES

A. Outlet boxes for concealed wiring systems: Sheet metal, galvanized or cadmium plated.

B. Minimum 4” (100 mm) square, 1-1/2” (38 mm) deep, sized to accommodate devices and number of conductors in accordance with NEC. Equip with plaster ring or cover as necessary for flush finish.

C. Exposed conduit systems shall have surface-mounted boxes unless specified otherwise. Boxes for exposed wiring in nonhazardous, noncorrosive, and nonweatherproof locations shall be malleable iron, cadmium finish or cast aluminum alloy, minimum 4” (100 mm) square, 1-1/2” (38 mm) deep.

D. Enclosures shall be as required for areas in which they are installed and as specified.
1. Boxes: Install flush in masonry construction and design for intended use.
2. Recessed boxes:
a. Where fixture is mounted, boxes shall be minimum 4” (100 mm) and octagonal in shape or 4” (100 mm) square by 1-1/2” (38 mm) deep with round plaster ring.
b. Where used as junction box, boxes shall be minimum 4” (100 mm) square by 2-1/8” (53 mm) deep.
3. Outlet boxes for wall concealed telephone and signaling systems: 4” (100 mm) square by 1-1/2” (38 mm) deep, minimum. Furnish with plaster ring and cover plate.
4. Floor boxes for floor outlets:
a. Cast-metal with threaded conduit entrances, brass flange ring and brass duplex flap cover plate.
b. Watertight with leveling and adjustment screws for adjusting cover plate to finished floor.
c. Minimum 4” (100 mm) diameter and 3-1/2” (88 mm) deep with approved gasket or seal between adjusting ring and box.
5. Floor outlets for combination signaling, data, and power outlets: Construct of steel base, PVC housing, and steel bracket to allow feed through wiring and activation load-bearing support. Box construction shall meet UL 514A requirements.
a. Entire housing shall be removable for unrestricted access.
b. Once assembled, PVC housing shall be capable of carrying 6,000 lb (2722 kg) load.
c. Coordinate outlet requirements with communication system requirements.
6. Floor boxes in 2-hour rated floors shall be secured in cored hole and shall be UL classified and listed for 2-hour rated floors.

2.07 PULL AND JUNCTION BOXES

A. Furnish junction boxes and pull boxes were shown on Drawings, and where necessary to facilitate pulling wires and cables without damage.

B. Above ground boxes shall be formed from sheet steel, with corners folded in and securely welded with inward flange on each of 4 edges.

C. Drill box for mounting and attachment of cover; galvanize after fabrication.

D. Cover: Construct of one-piece galvanized steel and provide with stainless steel round head machine screws.

E. Box and cover shall be made of code gage steel, or heavier if shown on Drawings.

F. Size: Minimum 4-1/2” (113 mm) deep and in accordance with NEC. Use next larger standard size when necessary in accordance with manufacturer standard sizes.

G. Furnish pull and junction boxes without knockouts for field drilling.

H. Enclosures shall be as required for areas in which installed and in accordance with requirements specified.

I. Underground boxes: Specifically design and construct for intended installed location, and be either pre-formed concrete or PVC. Covers shall be capable of withstanding, without failure, type of traffic in general area.

J. If pull and junction boxes are exposed in and around architecturally finished surfaces, paint box to match finish of nearby surfaces, unless indicated otherwise.

K. Bolt-on junction box covers 3'-0" (900 mm) square or larger, or heavier than 25 lb. (11 kg) shall have permanent rigid handles. Covers larger than 3'-0" x 4'-0" (900 mm x 1200 mm) shall be split.

2.08 EQUIPMENT SAFETY GROUNDING

A. Install exposed raceway electrically continuous. Conduit and tray shall not be considered to be only ground conductor.

B. Furnish equipment that is part of integral shipping unit or assembly with bare copper ground conductor extending to central ground connection lug. Lug shall be suitable for field connection to local ground. Electrical equipment shall be considered any device that is energized.

C. Single-point ground connections required for proper operation of electronic equipment shall be insulated from equipment safety ground. Such connections shall be extended, using insulated cable, to single insolated termination point suitable for field connection to appropriate ground system.

D. Conduits containing power circuits shall have ground conductor installed inside conduit. Ground conductor shall be bonded to equipment or tray or duct ground at both ends.

E. Provide ground bushing on each conduit containing power circuit. Connect ground bushings together inside enclosure and to enclosure ground lug or ground bus.
   1. Use No. 8 AWG conductor for ground bushings trade size 1-1/2” (38 mm) and smaller.
   2. Ground bushings larger than 1-1/2” (38 mm) shall be sized in accordance with requirements of NEC, but in no case shall bushings be smaller than No. 8 AWG.

F. Ground conductor: Uninsulated, Class B standard, round soft drawn uncoated copper as defined in ICEA S-19-81, unless specified otherwise.

G. Hardware: Clamps, bolts, washers, nuts, and other hardware used with grounding conductor shall be copper, copper alloy, high copper alloy, or silicon bronze.

2.09 PIN AND SOCKET CONNECTORS

A. Unless shown on Drawings, not allowed.

2.10 FUSES AND FUSE BLOCKS

A. Modular-type, Class H screw terminal fuse blocks with Bakelite frame and reinforced retaining clips. Blocks shall be similar in construction and by same manufacturer.

B. Slow blow fuses: Bussmann Type MDL or Gould Shawmut Type GDL with ampere ratings of 1/4, 1/2, 1, or 2.

C. Fast acting fuses: Bussmann Type NON or Gould Shawmut Type OT with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.

D. Extremely fast acting fuses: Bussmann Type KAB with ampere ratings of 1, 3, 6, 10, 15, 20, or 30.

2.11 ELECTRICAL METERS

A. Meters for measuring electrical quantities shall be utility grade, multifunction, switchboard-type with accuracy of ±0.2% or better for volts and amperes, and 0.4% for power functions.

B. Readouts shall have true RMS capability with at least 1/2” (13 mm) high intensity LED displays and be capable of surge withstand exceeding IEEE C37.90.1.

C. Instruments checked in field and found to be inaccurate in excess of percent error shall be returned for replacement without cost to Owner.

D. Design meters for operation through 5-ampere current transformer secondary and 120-volt voltage transformer secondary.

E. Provide communications capability; coordinate with Owner.

2.12 CONTROL RELAYS

A. General service, industrial grade auxiliary relays rated 600-volt.

B. Contacts: Reversible from N.O. to N.C. in field.

C. Timing relays for critical service: Agastat Series 7000.

2.13 CONTROL SWITCHES

A. Multistage, rotary-type rated 120 volts ac or 125 volts dc, 3 amperes, as required.

B. Handles: Black, fixed, modern, pistol grip type. Provide engraved black plastic escutcheon plates with targets.

C. Provide with colored LED lamps and nameplates as required.

2.14 PUSHBUTTONS

A. Standard pushbuttons: Heavy, industrial-type rated 120 volts ac or 125 volts dc, 3 amperes, as required.

B. Provide with colored LED lamps and nameplates as required.

2.15 INDICATING LIGHTS

A. Status indicating lights: High-intensity, cluster, LED-type for panel mounting.

B. Coordinate indicating light colors with indicated conditions as follows. Indicating lights shall be energized when condition exists and shall be de-energized when condition does not exist:
   1. Red: Equipment energized: such as motor running, valve open, or breaker closed.
   2. Green: Equipment de-energized: such as motor stopped, valve closed, or breaker open.
   3. Amber: Equipment abnormality: such as motor trip, breaker trip, or relay trip.
   4. White: Monitoring of control power or trip coil: such as lockout relay trip coil monitor or breaker trip coil monitor. Light is on during normal circuit operation and off during loss of power or loss of coil.
   5. Blue: Loss of control power.

2.16 ALARM AND TRIP CONTACTS

A. Alarm contacts for remote annunciation: Suitable for operation at 120 volts ac and 125 volts dc. Contacts shall be rated at least 0.5-ampere make and break, minimum.

B. Alarm contacts: Normally closed contacts that open to alarm condition.

C. Trip contacts for remote trip: Suitable for operation at 125 volts dc and rated 5 amperes make or break, minimum.

2.17 LOCAL SEPARATE DISCONNECT SWITCHES

A. Three-pole, nonfusible, heavy-duty, rated 600-volt with continuous current rating as shown on Drawings and as required by load.
   1. Type: Either molded-case or blade.
   2. Switches shall use high-conductivity copper for current carrying parts.

B. Switches shall be positive, quick-make, and quick-break mechanisms.
   1. Switch assembly plus operating handle shall be integral part of enclosure base.
   2. Each switch shall have handle whose position is easily recognizable and which can be locked in “On” and "Off" position with 3 padlocks. "On" and "Off" positions shall be clearly marked.

C. Switches shall be UL-listed and horsepower rated. Where applicable, switches shall have defeatable door interlocks that prevent door from being opened while operating handle is in "On" position.

2.18 AUXILIARY POWER TRANSFORMERS

A. Provide separately mounted transformers as shown on Drawings.

B. Windings: Copper.

C. Transformers shall be self-air-cooled, dry-type, capable of wall- or floor-mounting, and enclosed for wiring connection by conduit. In areas where dust and dirt may be normally present, use encapsulated-type transformers.

D. NEMA enclosure type protection shall be as specified herein.

E. Provide at least 2 full kVA capacity voltage taps above and 2 full kVA capacity taps below nominal rating. Each tap shall be 2.5% step.

F. Transformer shall be capable of at least 150ºC rise above rated site maximum ambient without degrading transformer life.

G. Transformers shall be capable of continuous operation at rated kVA with normal life expectancy as defined in ANSI C57.

H. Sound level shall not exceed NEMA maximum average sound level.

I. Enclosure: Sheet steel with corrosion-resistant finish and manufacturer’s standard color.

2.19 PLATES AND COVERS

A. Provide finish plates and covers of appropriate type and size for wiring and control devices, signal, and communication outlets.

B. Mark each plate and cover to show circuit and panel designation. Unless indicated to be engraved plate, use self-sticking, clear membrane, UV-resistant labels with typed black letters. Handwritten labels not allowed.

C. Coordinate color with adjacent surfaces.

D. Raised cover galvanized steel plates shall be acceptable for use on surface-mounted outlet boxes in unfinished areas where weatherproof plates are not required.

E. For weatherproof installations, cover plates shall be gasketed and rated for NEMA Type 4 installation.

F. Device plate mounting hardware shall be countersunk and finished to match plate.

2.20 WIRING DEVICES

A. Where more than one flush device is indicated in same location, mount devices in gangs under common plate.

B. Switches for control of ac lighting panel load circuits, single-pole, 3-way, and 4-way, shall be premium, heavy-duty specification-grade, and meet FS W-S-896E. Switches shall be rated for use at 120 or 277 volts and 20 amperes minimum.

C. Device color, if not shown on Drawings, shall be coordinated to match adjacent finishes.

D. Wall switches requiring pilot light indication shall have red LED pilot light when toggled “On.”

E. Pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, and center "Off."

F. Standard convenience outlets: Premium, heavy-duty, specification-grade, duplex, 3-wire, grounding, 20-ampere, 125-volt for 120-volt circuits, and rated 250-volts for 240 or 208-volt circuits.

G. Ground fault circuit interrupter (GFI) receptacles: Duplex, 20-ampere, and 125 volts, feed-through type.

H. Isolated ground (IG) outlets: Duplex, 3-wire, with isolated grounding terminal, 20-ampere, and 125 volts. Outlets shall be orange in color, unless specified otherwise.

2.21 WELDING

A. If special welding requirements are required for any piece of equipment during installation, requirements shall be stated on manufacturer’s shop drawing of affected part.

B. Furnish detailed welding requirements with equipment shipment.

2.22 PANELBOARDS

A. Dead-front, circuit breaker type, rated for voltage, phase, with main lugs or main breaker as indicated on panel schedules.

B. Enclosure shall be NEMA-rated for installation location and capable of flush or surface mounting.

C. Enclosure cover and access door shall be hinged with breaker operating handles accessible through latchable and lockable door.

D. Typed panel directory located inside door shall have panel and circuits function clearly identified. Handwritten panel schedules not allowed.

E. Provide main and neutral buses insulated from cabinet with separate ground bus. Bus material shall be copper. Ground bus shall be similar to neutral bus in size and number of conductor terminating positions.
   1. Bond ground bus to panelboard enclosure by copper ground strap or copper conductor of appropriate size. Bond neutral bus to ground bus in accordance with requirements of NEC.
   2. Grounding bus connection to enclosure by removable screws not allowed.
   3. Bus shall be capable of terminating clamp type lugs for neutral cable in each supply conduit, and connections for neutral cable in each load circuit.
   4. Neutral bus shall be fully rated, unless specified otherwise.
   5. Isolated ground panelboards: As specified above, except isolated ground bus shall be bonded, by insulated ground conductor, back to source of separately derived system. Do not bond isolated ground bus to panelboard enclosure unless this is first point of grounding for separately derived system.

2.23 CIRCUIT BREAKERS

A. Molded-case, thermal-magnetic, bolt-in, individually front replaceable, and shall visibly indicate "On," "Off," and "Tripped" position.

B. Branch circuit breakers used for lighting circuits shall be switch duty rated, “SWD.”

C. Breakers having multiple poles shall be manufactured as common trip type.

D. Interrupting rating shall be not less than interrupting rating of panelboards, and not series rated to achieve required short circuit interrupting rating.

E. Provide handle clips for 10%, or minimum of 2 whichever is greater, for breakers to prevent casual operation. If no breakers are indicated for installation, then provide on breakers labeled as spare.

F. Breakers, and provisions for future breakers, shall be provided in quantities, poles, and ampere ratings shown on Drawings.

G. Molded-case circuit breakers used in ac and dc panelboards and ac load centers shall be bolt-on type, G-frame size.

2.24 FINISHES

A. Manufacturer’s standard coating systems shall be factory-applied. Coating systems shall provide resistance to corrosion caused by weather and industrial environments.
   1. Surfaces inaccessible after factory or field assembly shall be protected for life of equipment.
   2. Painted surfaces shall be filled to provide smooth, uniform base for painting.
   3. Surfaces requiring field welds shall not be coated within 3” (75 mm) of field weld.

B. Coating material and application techniques shall conform to regulations of air quality management agency having jurisdiction.

C. Exterior surfaces of control and electrical equipment, including panels, cabinets, switchgear, transformers, and motors shall be manufacturer’s standard colors unless specified otherwise.

D. Apply high-temperature coating systems to uninsulated equipment operating at temperatures at or above 200°F (93°C).

2.25 RUST-INHIBITOR COMPOUNDS

A. Uncoated machined and ferrous surfaces subject to corrosion shall be protected with rust-inhibitor compounds.

B. Rust-inhibitor compounds used to protect surfaces of equipment and piping exposed to feedwater or steam shall be completely water-soluble.

C. Surfaces to be field welded shall be coated with consumable rust-inhibitor compounds that will not affect quality of weld.

D. External gasket surfaces, flange faces, couplings, rotating equipment shafts and bearings shall be thoroughly cleaned and coated with rust-inhibitor compounds.

2.26 GALVANIZING

A. Galvanized structural steel members and steel assemblies shall be pickled after fabrication. Remove scale, rust, grease, and other impurities, then hot-dip galvanized in accordance with ASTM.

B. If galvanized member is to be bolted, structural bolts shall be galvanized in accordance with ASTM.

2.27 IDENTIFICATION AND TAGGING

A. Conduits inside manholes, hand holes, building entrance pull boxes, and junction boxes shall be provided with 19-gage (1 mm) stainless steel identification tags, with 1/2" (13 mm) stamped letters and numbers.
   1. Attach conduit Identification tags with stainless steel banding. Tag position shall be readily visible for inspection.
   2. Tags shall provide, as minimum:
      a. Circuit origination and destination.
      b. Voltage.
      c. Number of conductors in accordance with phase.
      d. Number of phase conductors.

B. Cables passing through or terminating in manholes, hand holes, and pull boxes shall have 19-gage (1 mm) stainless steel identification tags with stamped lettering that provides circuit identification information.

C. Provide power, control, and instrumentation cables with permanent type identification markers with typed cable numbers and from/to information at each point of termination. Cable numbers and from/to information will be provided for circuits not associated with low-voltage panelboards.
   1. Position cable markers to be readily visible for inspection.
   2. Cable numbers shall match those as shown on Drawings.
   3. Provide wire tags at each termination point for each conductor. Tags shall be permanent, wrap around, heat-shrinkable type with typewritten information.

D. Color-code power conductors with electrical tape or provide with colored jacket.
   1. Source voltage of 120/240 volts:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Neutral: White.
   2. Source voltage of 240/120-volt delta: High-leg systems shall not be used without Engineer approval.
   3. Service entrance and equipment ground conductors shall be bare copper or green insulated conductor. Equipment bonding conductors shall be bare copper.
   4. Isolated ground conductors shall be insulated; green in color with integral yellow stripe. No substitutions.

E. Signage:
   1. Provide proper signage, plaque, directory and warning labels for electrical equipment and raceway in accordance with NEC requirements.
   2. One-line diagram: Display unfolded and behind clear plastic so diagram is clearly visible.
   3. Mount diagram to permanent structure or wall and located within sight of each feeder, branch-circuit disconnect, each service disconnect, and switchgear. Place permanent legible warning sign in conspicuous location with wording "Danger – High Voltage" required for following areas over 600 volts:
      a. A "Danger – High Voltage" warning sign lettering shall be a minimum of 1" (25 mm) high and remaining lettering a minimum of 1/4" (6 mm) high.
      b. Locations:
         1) At entrances to electrical equipment vaults and electrical equipment rooms, areas, or enclosures, and manholes and handholes, unless words are cast into access cover.
         2) At points of access to conductors on high-voltage conduit systems and cable systems.
         3) On cable trays and cable trench containing high-voltage conductors with maximum spacing of warning notices not to exceed 10' (3 m).
         4) On metal-clad and metal-enclosed switchgear panels or doors providing access to live parts over 600 volts [a], [Article 225.70].
         5) On isolated phase and nonsegregated phase bus duct, at access openings unless Owner has a differing standard.

2.28 EQUIPMENT NAMEPLATES

A. Laminated white-over-black plastic such that face is white with black letters, with 1/8” (3 mm) engraved letters securely fastened with minimum of 2 self-tapping, stainless steel screws.

B. Motor starters, either separately mounted or contained in motor control centers, shall have nameplates identifying related equipment. Where separate control and indicating lights are used, starters shall have engraved or etched legends ("start", "stop", etc.) as shown on Drawings.

C. Provide control stations with nameplates identifying related equipment. Control and indicating lights shall have engraved or etched legends as shown on Drawings.

D. Circuit breakers within main switchboards and distribution switchboards shall be provided with nameplates identifying related equipment being served.

E. Fused and nonfused switches shall have 2 front cover-mounted nameplates.
   1. Nameplate containing permanent record indicating switch type, manufacturer's name, catalog number, and appropriate rating for equipment served.
   2. Provide additional nameplate to identify associated equipment.

F. Panelboards shall have front cover-mounted nameplates identifying panelboard, matching information shown on Drawings and associated panel schedule. Nameplate shall have at least 4 lines of text consisting of:
   1. Line 1: Panel equipment identification number.
   2. Line 2: IEEE Voltage Designation.
   3. Line 3: Appropriate description from which power is derived, (i.e. fed from HP1 through XFMR-LP1).
   4. Line 4: Location of power source, (i.e. PP-1, NW wing).

G. Lighting and auxiliary power transformers shall have front cover-mounted nameplates identifying transformer, matching information shown on Drawings. Nameplate shall have at least 2 lines of text that consist of:
   1. Line 1: Transformer equipment identification number.
   2. Line 2: Location of derived power source (i.e. fed from MDB, Elec Rm Basement).

H. Nameplates shall meet requirements of NFPA 70E

2.29 HARDWARE

A. Provide hardware including, but not limited to, anchor bolts, nuts, washers, expansion anchors, wire nuts needed for installation.

B. Hardware smaller than 3/4” (19 mm) shall match NEMA standard size bolt holes on motors and electrical equipment.

2.30 LOGIC SYSTEMS FACTORY TESTING

A. Prior to shipment, test electrical equipment containing solid-state logic systems in accordance with manufacturer’s standard tests for minimum of 120 hours under power.
   1. Components tested shall include electronic devices; power supplies, input-output devices, operator interface devices, and interconnecting cables provided with system.
   2. System shall be tested as complete assembly. Testing of individual components or modules not allowed as system tests.

B. System test shall include:
   1. Means of confirming logic or mathematical design response of system by simulating changes in system input.
   2. Test shall repeatedly cycle system through operations system will be expected to perform in service with loads on various components equivalent to those which will be experienced in actual service.
   3. Adjustment of power source voltages to high and low limits. Verify correct operation of system at both high and low power source voltage limits.

C. System shall be tested and verified capable of providing surge withstand capability in accordance with requirements of ANSI C37.90.1.

D. Perform tests with solid-state logic system exposed to ambient temperature appropriate to service for which associated electrical equipment is designed.

PART 3 EXECUTION

3.01 EXAMINATION OF SITE

A. Contractor shall be responsible for familiarity with Project Site conditions. Equipment furnished and installed shall be capable of withstanding most severe conditions that will be encountered.

3.02 PROTECTION OF WORK

A. Protect installed Work and provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

B. Damage occurring to building or equipment during installation shall be repaired or replaced to conditions existing prior to damage at no additional cost or delay to project or Owner.

3.03 INSTALLATION

A. Install equipment and materials in accordance with manufacturer's recommendations and Drawings.

B. Details for equipment and systems installed in accordance with industry standard techniques will not be furnished.

C. Installation details furnished on Drawings shall be followed unless found to be unsafe, inappropriate for equipment specified, or unachievable due to site conditions.

D. Install equipment indicated on Drawings as furnished by others, unless noted as installed by others, including but not limited to:
   1. Medium-voltage switchgear.
   2. Medium-voltage bus duct.
   3. Secondary unit substations.

E. Except as otherwise specified or indicated on Drawings, equipment shall be installed plumb, square, and level.

F. Sheet metal junction boxes, equipment enclosures, sheet metal raceways, and similar items mounted on earth-bearing walls shall be separated from wall not less than 1/4” (6 mm) by corrosion-resistant spacers.

G. Substations, switchgear, motor control centers, and similar equipment located outdoors shall be permanently sealed at base. Openings into equipment shall be screened or sealed as to prevent entrance of birds, rodents, and insects the size of wasps and mud daubers.

1. Sealing material at base shall be concrete grout.
2. Small cracks and openings shall be sealed from inside with silicone sealant.
3. Large openings shall use galvanized screen mesh.

3.04 TRIP SETTING COORDINATION

A. Motor overload protection shall be selected and set by Contractor based on final motor nameplate information. Size motor circuit protectors to coordinate with motor starting characteristics and overload protection. Submit summary of settings to Owner, list:
   1. Equipment project identification number.
   2. Nameplate information.
   3. Overload device trip range.
   4. Overload device setting.
   5. Trip device rating.
   6. Trip device setting if different from rated value.

B. Set trip devices and verify devices are operating within manufacturer's tolerances. Make changes to settings not complying with requirements furnished by Engineer. Device settings will be furnished for following equipment:
   1. Medium-voltage system.
   2. Low-voltage switchgear.
   3. Secondary unit substations.

3.05 CABLE

A. Prior to installation of each cable or cable group into assigned raceway, verify that raceway has been correctly sized.
   1. Where raceway is not indicated in circuit schedule or on Drawings, size in accordance with requirements of NEC.
   2. If raceway size indicated on Contract Documents is inadequate, notify Engineer.

B. Replace cables pulled into wrong raceway or cut too short to rack and train.

C. Do not reinstall cables installed in wrong raceway and removed. Discard cables unless inspected and accepted by Owner's Representative in writing.

D. Carefully lay or pull circuits in cable tray so neither cables nor tray is damaged.

E. Protect cables from dirt, water, oil, damaging chemicals, and from physical injury prior to, and during installation.

F. Cables shall be cut sufficiently long to conform to contour of trays, with particular attention paid to vertical inside bends.

G. Remove excessive slack so cables lie parallel to sides of trays.

H. Multiple single-conductor power cables No. 1/0 AWG (50 mm^2) or larger installed in cable tray that constitute single power circuit shall be grouped together in triplexed or quadriplexed arrangement. Maintain cable spacing to be 2.15 x O.D. of largest conductor in group or adjacent group.

I. Multiconductor power cables No. 4/0 AWG (120 mm^2) or larger installed in cable tray shall be installed in single layer with maintained spacing of not less than 1 cable diameter of largest cable.

J. Fasten cables to cable tray with rated nylon ties to hold cables in place.

K. Perform fishing and pulling with flexible round metal tape, CO_2 propelled polyethylene cord, nylon rope, or manila rope.

L. Cable damage caused by improper pulling tension and excessive sidewall pressures shall be considered for any cable pulls that require use of mechanized cable pulling machine, whether installed underground or overhead.
   1. NEC requirements shall be used as guideline. Calculations shall be performed for duct bank runs over 300’ (90 m), and for installations in conduit over 100’ (30 m).
   2. Monitor pulling tension during installation of cable. Tension shall not exceed maximum recommended by cable manufacturer.
   3. To avoid damage from excessive sidewall pressure at bends, pulling tension shall not exceed cable manufacturer’s recommendation.
   4. Pulling mechanisms, manual or power type, shall have rated capacity in tons legibly marked on mechanism.
   5. During installation, observer shall constantly watch dynamometer and record maximum tension achieved during pull.
      a. If excessive strain develops, stop pulling operation at once. Determine difficulty and correct.
      b. Provide records of dynamometer readings to Engineer.
      c. Inform Owner prior to cable pulls.
   6. Do not use woven wire cable grips. Only use pulling eyes for pulling cables.
   7. As soon as cable is pulled into place, remove pulling eyes and reseal cable.

M. Insert reliable nonfreezing type of swivel or swivel connection between pulling rope and eye to prevent twisting under strain.

N. Only use lubricants as recommended by cable manufacturer. Water-based lubricants not allowed.

O. Outside of each cable reel shall be carefully inspected. Remove protruding nails, fastenings, or other objects that might damage cable.
   1. Perform visual inspection for flaws, breaks, or abrasions in cable sheath as cable leaves reel. Pulling speed shall be slow enough to permit inspection.
   2. Damage to sheath or finish of cable shall be sufficient cause for rejecting cable.
   3. Cable damaged during installation shall be replaced at no expense to Owner.

P. Permanent radius of each bend after cable installation shall be in accordance with manufacturer's recommendations.

Q. Cable supports and securing devices shall have bearing surfaces located parallel to surfaces of cable sheath. Install to provide adequate support without deformation of cable jackets or insulation.

R. Provide adequate cable end lengths. Properly install in junction boxes and manholes to avoid longitudinal strains and distorting pressures on cable at conduit bushings and duct end bells.

S. Final inspection shall be made after cables are in place. Where supports, bushings, and end bells deform cable jacket, provide additional supports.

T. Splices, joints, and connections shall be made only in accessible junction boxes in accordance with methods specified and instructions of cable manufacturer. Splices not allowed unless shown on Drawings.

U. Rough-in wiring terminated in junction boxes shall have at least 8” (200 mm) of free conductor coiled in box for connection to equipment and receptacles.

V. Circuit information for circuits originating from panelboards is indicated on panel schedules. Other circuits are identified on circuit schedule.
   1. Do not combine receptacle loads with lighting loads.
   2. Circuits fed from panelboards shall not be combined with circuits from circuit schedule.

W. Panelboard circuits are indicated as individual runs. Circuits may be combined into common conduits in accordance with rules of NEC. Perform work associated with combining of circuits at no additional cost to Owner.

3.06 WIRING DEVICES, BOXES, AND FITTINGS

A. Install galvanized or cadmium plated, threaded, malleable iron boxes and fittings in:
   1. Embedded in concrete walls, ceiling, and floors.
   2. Outdoor exposed faces of masonry walls.
   3. Locations where weatherproof cover is required by code or this specification.

B. Install galvanized or cadmium plated sheet steel boxes in:
   1. Indoor exposed faces of masonry walls.
   2. Interior partition walls.
   3. Joist supported ceilings.

C. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

D. Telephone and communication conduit systems shall have separate junction boxes and pull fittings.

E. Install fire system wiring in dedicated conduit system.

F. Finish openings so standard sized cover plates can be used. Oversized plates not allowed.

G. Mount wall switches 3’-6” (1050 mm) above finished floor or grade unless specified otherwise. After circuits are energized, test wall switches for proper operation.

H. Outlets:
   1. Standard mounting height: 18” (450 mm) above finished floor, unless specified otherwise.
   2. Outlets outdoors, garages, basements, shops, storerooms, and other rooms where equipment may be hosed down: 4'-0" (1200 mm) above finished floor or grade.
   3. Surface-mount welding receptacles 4'-0" (1200 mm) above finished floor or grade.
   4. After circuits are energized, test each receptacle for correct polarity.
   5. Test GFCI receptacles for proper operation.
   6. Mount wall thermostats 5'-6" (1650 mm) above finished floor unless noted otherwise. Thermostats mounted shall be suitably insulated from wall temperatures.

I. Communication outlets:
   1. 18” (450 mm) above finished floor unless required otherwise.
   2. Outlets outdoors, garages, basements, shops, storerooms, and rooms where equipment may be hosed down: 4'-0" (1200 mm) above floor.

J. Clock outlets: Locate 7'-0" (2.13 m) above finished floor or grade.

3.07 GROUNDING AND BONDING

A. Electrical system and equipment grounding shall be installed in accordance with NEC and shall conform to following, where applicable:
   1. Ground conductors shall be bare or green-insulated in accordance with NEC.
   2. Cable shall be soft-drawn copper or copper bar, sized in accordance with drawings and NEC, but not smaller than No. 12 AWG.
   3. Ground cable splices and joints inaccessible upon completion of construction shall meet requirements of IEEE 837 and shall be exothermic weld or compression system type.
   4. Ground cable through exterior building walls not in conduit shall enter within 3’ (1 m) below finished grade and shall be provided with water stop. Installation of water stop shall include filling space between strands with solder and soldering 12” (300 mm) copper disc over cable.
   5. Ground cable near base of structure shall be in undisturbed earth and as far from structure as excavation permits, but not closer than 6” (150 mm).
   6. Copper ground conductor in addition to conduit connection shall ground each piece of electrical equipment.
   7. Copper or high-conductivity copper alloy ground lugs or clamps shall make ground connections to equipment and ground buses. Connections to enclosures not provided with ground buses or ground terminals shall be made by clamp-type lugs added under permanent assembly bolts or

under new bolts drilled and added through enclosures other than explosionproof, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers not permitted.
8. Bond grounding system to water piping by connection to first flange inside building from main that will form good ground connection. Make connection with copper bar or strap by drilling and tapping flange and providing bolted connection.
9. Ground conductors on equipment shall be formed to contour of equipment and firmly supported.
10. Ground rods not described elsewhere shall be minimum 5/8” (16 mm) diameter by 10’ (3.0 m) long, with copper jacket bonded to steel core.
11. Make connections to ground grid where shown on Drawings.
12. Verify connections by performing continuity checks.

3.08 FIREPROOFING AND FIRE RATINGS

A. Maintain fire-resistive integrity during construction.

B. Penetrations through fire-resistive structures shall be sealed with fire-resistive material compatible with construction penetration.

C. Where required by codes, local building officials, or fire marshal, furnish UL fire sealing systems and install in accordance with manufacturer’s recommendations.

3.09 STARTUP AND TESTING

A. Clean equipment interiors and exteriors prior to start-up and testing.

B. Unless specified otherwise, tests performed shall be standard tests listed by ANSI/IEEE for intended equipment.

C. Equipment shall be checked and placed in service ready for operation.

D. Circuits shall be electrically tested after installation. Test power and motor circuits prior to final connection to equipment. Splices shall be complete prior to testing.
1. Provide equipment and labor required for testing.
2. Circuit failing to test satisfactorily shall be replaced or repaired, and retested at no additional cost to Owner.
3. Check power and motor circuits, dc power, and control circuits for:
   a. Correct terminations.
   b. Continuity.
   c. Unintentional shorts and grounds.
4. Check power conductors for correct phasing.
5. Motor circuits shall be checked for proper rotation and motors "bumped" to verify correct machine rotation.
6. Control, instrumentation, and thermocouple wire shall be checked for correct termination, continuity, freedom from shorts or grounds, and identification.
7. Current transformer wiring shall be loop checked by injecting current at one end of loop and checking with clip-on ammeter at each field termination point to assure continuity and phase identification.
8. Voltage transformer wiring shall be tested by applying voltage at one point and checking with voltmeter phase rotation meter and phase angle meter at each field termination point to assure continuity, identification and phase shift.

3.10 DEMONSTRATION

A. Final start-up and check out shall be completed prior to Owner acceptance of project.

B. Electrical installation shall be complete in every detail and capable of normal operation in presence of Owner or Owner's Representative to verify its readiness.

END OF SECTION

1) B. A. Wachtel
2) L. E. Ingram

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Above grade conduit, wireway, boxes, and associated accessories for support, securing, and protection of electrical wiring.

1.02 INFORMATIONAL SUBMITTALS

A. Product Data:
1. List of proposed materials identifying manufacturer and type to be furnished.
2. Manufacturer's catalog sheets, marked as necessary to indicate specific type, model or catalog number for equipment to be furnished for project.

B. Quality assurance data:
1. Component and accessories data sheets.
2. Installation information.

C. Such other similar information as Engineer may request.

1.03 QUALITY ASSURANCE

A. Manufacturer’s qualifications:
1. Manufacturer shall be manufacturer of major components within assembly and shall be ISO certified.
2. Manufacturer shall have produced similar equipment for a minimum period of 5 years.

B. Regulatory requirements
1. Equipment shall be designed and manufactured in accordance with applicable requirements of following: NFPA 70; ANSI C80.1, C80.3, C80.4, C80.5; UL 1, UL 6, UL 360, UL 651, UL 797, UL 870, UL 1242; and NEMA TC2, TC3, TC6, TC9, and RN1.
2. Standards of foreign organizations shall not be used without written approval from Engineer.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Raceway systems and accessories shall include, but not be limited to:
1. Exposed and concealed conduit.
2. Elbows, fittings, and accessories.
3. Hardware for support, securing, and protection.
4. Wireways.

2.02 RIGID METAL CONDUIT, STEEL (RGS)

A. Material: Mild steel tube with continuous welded seam in accordance with ANSI C80.1, and UL 6.

B. Exterior and Interior protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Apply final coat of transparent zinc chromate to exterior. Exterior and interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking.

C. Thread pitch shall conform to ANSI/ASME B1.20.1. Taper shall be 3/4”/ft (62.5 mm/m).

D. Each length of conduit shall have UL listing label.

E. Couplings, unions, and fittings: Threaded-type, galvanized steel.

F. Conduit bodies: Threaded or threadless type, cast metal or malleable iron type with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners.

G. Running thread not acceptable.

2.03 RIGID METAL CONDUIT, STEEL, POLYVINYL CHLORIDE COATED (PVC-RGS)

A. Requirements of article “Rigid Metal Conduit - Steel (RGS)” shall apply.

B. Coating: Apply minimum 40-mil, gray polyvinyl chloride (PVC) coating over exterior and apply urethane coating uniform and consistent to interior of conduit. Internal coating shall be nominal 2 mil thickness. Conduit having areas with thin or no coating, not acceptable. Protect conduit threads by urethane coating. PVC coating shall have been investigated by UL as providing primary corrosion protection for rigid metal conduit.

C. Fittings, and conduit bodies: Threaded type, PVC-coated. PVC coating on outside of conduit couplings shall have series of longitudinal ribs, 40 mils in thickness, to protect coating from tool damage during installation. Manufacturer of couplings, fittings, and conduit bodies shall be same as conduit manufacturer. Hazardous location fittings shall be manufactured prior to application of plastic coating, and shall be UL-listed.

D. PVC exterior and urethane interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).

2.04 INTERMEDIATE METAL CONDUIT (IMC)

A. Material: High-grade sheet steel with continuous welded seam.

B. External protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Coating shall not flake or crack when conduit is bent. Internal coating of enamel or similar material resulting in smooth surface.

C. Fittings: Threaded or threadless type, galvanized steel or malleable iron.

D. Conduit bodies: Threaded-type, cast metal, or malleable-iron type, with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners

E. Running thread not acceptable.

2.05 ELECTRICAL METALLIC TUBING (EMT)

A. Material: Hot-dipped galvanized, high-grade steel with continuously welded seam.

B. External protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Coating shall not flake or crack when conduit is bent.

C. Internal coating: Baked enamel or similar compound resulting in smooth surface.

D. Fittings: Rust-resistant steel compression type. Connectors shall have insulated insert in throat. Die-cast aluminum material, and indent or set screw type, are not acceptable.

E. Conduit bodies: Malleable iron for use with compression type fittings. Set screw type not acceptable.

2.06 FLEXIBLE METAL CONDUIT (FMC)

A. Material: Galvanized mild steel.

B. Construction: One continuous length of steel strip of uniform weight and thickness and shaped in interlocking convolutions; fabrication shall result in smooth interior and exterior surfaces, reduced or full wall.

C. Fittings: Cadmium-plated steel, malleable iron, or zinc alloy. Screw in type, 1/2” (13 mm) and 3/4” (19 mm) shall have high-density polypropylene liners.

2.07 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Material: Mild steel, galvanized.

B. Construction: One continuous length steel strip of uniform weight and thickness and shaped in interlocking convolutions; fabrication shall result in smooth interior surface.

C. External coating: Provide outer jacket of tough extruded polyvinyl. Jacket shall be positively locked to steel core and be sunlight resistant and listed as oil resistant.

D. Continuous integral grounding strip: Required in sizes 1-1/4” (31 mm) and smaller. Ground wire shall be required for larger sizes.

E. Fittings: Cadmium or zinc-plated steel or malleable iron. Compression type with tapered hub and synthetic rubber gasket and ground ferrule for making positive ground contact with steel core, designed to prevent outer jacket from pulling away from steel core. Connectors shall have insulated insert in throat. Suitable for grounding through 1-1/4” (31 mm) trade size, provide ground wire lug for sizes 1-1/2” (38 mm) and larger.

2.08 RIGID NONMETALLIC CONDUIT, POLYVINLY CHLORIDE (PVC)

A. Material: PVC Schedule 40, and Schedule 80. Schedule 40 shall be rated for above-grade installation.

B. Fittings, elbows, and accessories: Connect to conduit by solvent-type cement process. Material shall be same as conduit.

C. Transition for connection of plastic conduit to rigid metal conduit shall be threadless solvent-type cement connection to PVC, with threaded connection to rigid metal conduit.

2.09 PULLBOXES AND JUNCTION BOXES

A. General use areas, protected or indoor: Galvanized sheet steel with a metal thickness meeting UL 50. Provide removable covers attached with round head silicon bronze machine screws.

B. Process or wet locations, indoor or outdoor: Galvanized steel or aluminum with gasketed covers attached with stainless steel hardware using raintight hubs.

C. Hazardous areas: UL-approved for area classification.

D. Where required for elbows, fittings, and accessories to be furnished by same manufacturer as conduit, boxes shall also be furnished by conduit manufacturer or by supplier approved by manufacturer.

2.10 WIREWAY

A. Metal gage thickness shall conform to NEC.

B. NEMA 1: Minimum 16-gage steel with baked enamel finish, hinged or removable covers with captive stainless steel screws.

C. NEMA 3R: Minimum 16-gage galvanized steel with baked enamel finish, gasketed drip-shield cover, with stainless steel screws, weatherproof.

D. NEMA 4X: Minimum 14-gage Type 304 stainless steel with neoprene gasket, hinged cover, stainless steel external screw clamps, and external mounting tabs.

E. NEMA 12: Minimum 16-gage steel with baked enamel finish with gasketed, hinged cover with stainless steel screws, dust-tight.

F. Screws shall be guarded to prevent damage to wire installation.

G. Provide fittings, supports, end plates, and accessories as required.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Coordinate timing of installation and locations of raceway with other trades. Do not block access or impede construction.

B. Locations of above grade raceway indicated on Drawings are approximate. Coordinate actual locations in field to avoid conflicts with other equipment.

C. Areas designated for, but not limited to; access, maintenance, hatchway, tube removal, and expansion shall be kept clear of field-routed raceway.

D. Exposed raceway runs shall be installed parallel or perpendicular to dominant surfaces with right-angle turns made with symmetrical bends or fittings.

E. Install exposed raceway minimum of 6” (150 mm) from outside surface of insulation and lagging on hot water pipes, steam pipes, and other heat sources. Install minimum of 12” (300 mm) from uninsulated heat sources. Avoid long runs parallel to heat sources.

F. Use expansion fittings where necessary. When expansion or deflection will be greater than 6” (152 mm) or greater than fitting is designed to accommodate, provide junction boxes solidly mounted on each side of expansion joint and connect with flexible, liquidtight conduit, or adjust conduit sections to limit expansion to less than 6” (152 mm).

G. Support raceway independently from equipment, and temporary or movable structures.

H. At minimum, identify raceways at both ends with raceway numbers. Markers shall be adhesive, UV-resistance type with 1” (25 mm) high lettering.

3.02 USES AND LIMITATIONS

A. Refer to NEC for guidelines regarding use, and limitation of each type of conduit. Follow NEC except as specified otherwise herein, or as shown on Drawings.

B. PVC-RGS: Acceptable for corrosive areas. Install conduit system in accordance with manufacturer’s installation manual. Installer shall be certified by manufacturer to install coated conduit.

C. IMC: Use only for circuits rated 600 volts or less. Do not use in areas deemed corrosive.

D. EMT: Use for concealed wiring in finished areas associated with lighting and small power circuits rated 600 volts or less. Do not use outdoors in concrete, or in damp or wet locations. Acceptable for use in nonhazardous, indoor, unfinished areas for lighting and communication, and specialty wiring.

E. FMC: 1/2" (13 mm) minimum size. Use only in dry, interior, noncorrosive, and concealed locations. Maximum length shall be 3' (1 m) for general use, and up to 6' (1.6 m) to light fixtures in concealed locations.

F. LFMC: 1/2" (13 mm) minimum size; 5' (1.5 m) maximum length.

G. PVC: Do not use schedule 40 PVC for exposed runs. Schedule 80 PVC sunlight-resistant conduit may be used for exposed runs if approved by Engineer.

H. ENT: Acceptable for limited use in nonindustrial applications for low-voltage, nonpower-related circuits; meet requirements of NEC and be acceptable to authority having jurisdiction.
   1. Blue - Security or access control.
   2. Yellow - Communication.
   3. Red - Fire or emergency.

I. Surface metal raceway and multioutlet assembly: Use in dry, general-purpose areas where shown on Drawings.

3.03 RIGID CONDUIT

A. Conduits not shown on Drawings shall be sized in accordance with NEC.

B. Conceal conduit in finished areas.

C. Drainage: Avoid water pockets in conduit runs; provide suitable fittings at low spots in exposed conduit where pockets cannot be avoided. Weep holes not permitted in conduit.

D. Conduit ends:
   1. Cap spare conduits with fittings designed for intended use.
   2. Conduit terminating in panels or enclosures where exposed to entrance of foreign material shall be plugged with commercial duct-sealing compound around conductors.
   3. Cap conduit ends during construction to prevent entrance of foreign material.

E. Where practicable, provide 3" (75 mm) stubbed up conduit for conduit entering into bottom of freestanding equipment. Coordinate locations with equipment. Terminate with grounding bushings.

F. Clean and swab inside of conduit by mechanical means to remove foreign materials and moisture before wires or cables are installed. Cleaning method shall not damage interior surface of conduit.

G. Bushings: Provide at termination of conduit not terminated in hubs and couplings. Insulating bushings with 150°C rated insulating inserts in metal housings shall be provided on conduit 1-1/4" (31 mm) and larger. Insulating bushings shall be grounding type. Standard bushings shall be galvanized.

H. Apply coat of zinc chromate to zinc-coated conduits where protective coating is damaged.

I. Couplings and unions:
   1. Threaded conduit couplings shall join metal conduit with conduit ends butted. Where standard threaded couplings cannot physically be used, join metal conduit using conduit unions or split couplings.
   2. Use ground-seat type, watertight unions where union may be submerged.

3. Install coupling nut in upper-most union to prevent entrance of water into union when used in vertical or inclined conduit runs.

J. Bends: Run of conduit shall not contain more than equivalent of three 90º bends, including offsets at outlets or fittings. Use only manufacturer-approved conduit bending equipment. Do not use deformed or crushed conduits.

K. Threads: Cut ends of conduit with saw; do not use wheel cutter. Conduit end shall have same number of threads as present from factory. Apply coat of zinc chromate to steel conduit threads and apply anti-seize compound containing powdered zinc or lubricating graphite to aluminum conduit threads.

L. Use expansion joints as required such that no more than 6” (152 mm) allowance for expansion or contraction of conduit occurs.

3.04 FLEXIBLE CONDUIT

A. Connect equipment that moves due to vibration, normal operation of mechanism, or thermal expansion, in relation to supported conduit using flexible conduit. Install junction boxes as required. Provide green ground wire.

B. Flexible metal conduit 1-1/2” (38 mm) and larger shall be installed with external lugs and external grounding conductor.

3.05 SPECIAL FITTINGS

A. Fittings installed outdoors or in damp locations shall be weathertight. Outdoor fittings shall be of heavy-duty construction.

3.06 CONDUIT SUPPORTS

A. Supports of structural steel or manufactured framing members shall be fabricated from lightweight channel approved by manufacturer for intended use, provide required rods, anchors, inserts, clamps, spacers, shims, bolts and accessories.

B. Clamps: Galvanized malleable iron 1-hole straps, beam clamps, or other device with necessary bolts and expansion shields.

C. Adjustable hangers: Use to support horizontal runs only. Use trapeze-type supports for parallel runs of conduit. Install U-bolts at end of each run and at each elbow. Install conduit clamps every third intermediate hanger for each conduit. Hanger rods shall be 3/8” (10 mm) minimum diameter threaded galvanized steel rods.

D. Conduits supports mounted on concrete surfaces: Fasten with self-drilling tubular expansion shell anchors with externally split expansion shells, single cone expanders, and annular break-off grooved chucking cones.

3.07 PENETRATIONS

A. Provide required penetrations in floors, walls, or roofs. Penetrations shall be kept to minimum, as small as possible, and installed in neat manner. Surrounding surfaces damaged during installation of penetrations shall be included as part of this work.

B. Seal penetrations in walls, floors, ceilings, and enclosures. Provide fire stops for electrical raceway penetrations. Maintain original fire rating that existed prior to commencement of work. Do not install fire seal for wire openings until interconnecting wiring of equipment is proven to operate properly.

C. Sleeves:
   1. Provide for passage of conduits through walls, floors, or partitions. Set sleeves in masonry during construction; set sleeves through concrete before placement begins.
   2. Material: Rigid conduit or pipe securely fastened in position.
   3. Cut sleeve flush with floor where conduit enters equipment enclosure otherwise extend sleeve 3" (75 mm) above floor.
   4. Sleeves through exterior building walls: Install conduit in center of sleeve. Pack interior and exterior annular space around conduit with plastic backer rod sized to fit annular space in compression as recommended by backing manufacturer. Seal interior and exterior of joint with acrylic polymer sealant.
   5. Sleeves through waterproof construction shall be flanged type.

D. Penetrations required after walls, floors, or ceilings are constructed shall be provided and grouted or sealed. Openings shall be core-drilled, do not jackhammer.

E. Patch and finish openings made in existing walls and floors to match original material in composition and appearance.

F. Cut or punch penetrations in wall panels. External penetration shall be flashed and calked to provide weather tight seal.

G. Limit penetrations in roofs to applications where required for connection to specific piece of equipment. When required, flash and apply seal material after installation of conduit to provide weathertight bond and seal. Materials shall be compatible with roofing system.

3.08 WIREWAY AND BOXES

A. Installed in accordance with manufacturer's recommendations.

B. Connections shall be made such that they maintain NEMA rating of enclosure and system.

C. Locations and quantities shown on Drawings are approximate. Make adjustments as required to eliminate field interferences or to meet requirements of NEC. Provide Engineer with information regarding new locations.

D. To access interior, locate to permit full removal of covers, or such that doors can be opened more than 100°. Mount at height as indicated, or as required by NEC, whichever is more restrictive.

E. Support wireways and boxes independently of conduits by means of bolts, screws, rod hangers, and other suitable means.

END OF SECTION

1) B. A. Wachtel
2) L. E. Ingram

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Below-grade conduit, boxes, and associated accessories for support, securing, and protection of electrical wiring.

1.02 INFORMATIONAL SUBMITTALS

A. Product Data:
1. List of proposed materials identifying manufacturer and type to be furnished.
2. Manufacturer's catalog sheets, marked as necessary to indicate specific type, model or catalog number for equipment to be furnished for project.

B. Quality assurance data:
1. Component and accessories data sheets.
2. Installation information.

C. Such other similar information as Engineer may request.

1.03 ACTION SUBMITTALS

A. Shop Drawings: Manhole and hand hole dimensional layouts.

1.04 QUALITY ASSURANCE

A. Manufacturer’s qualifications:
1. Manufacturer shall be manufacturer of major components within assembly and shall be ISO certified.
2. Manufacturer shall have produced similar equipment for a minimum period of 5 years.

B. Regulatory requirements
1. Equipment shall be designed and manufactured in accordance with applicable requirements of following; NFPA 70; ANSI C80.1, C80.3, C80.4, C80.5; UL 1, UL 6, UL 360, UL 651, UL 797, UL 870, UL 1242; and NEMA TC2, TC3, TC6, TC9, and RN1.
2. Standards of foreign organizations shall not be used without written approval from Engineer.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Raceway systems and accessories include, but shall not be limited to:
1. Direct buried ducts.
2. Concrete encased ducts.
3. Cable trench.
4. Elbows, fittings, and accessories.
5. Hardware for support, securing, and protection.
6. Manholes and handholes.
7. Trenching and backfilling.

2.02 RIGID METAL CONDUIT, STEEL (RGS)

A. Material: Mild steel tube with continuous welded seam in accordance with ANSI C80.1, and UL 6.

B. Exterior and Interior protective coating: Metallic zinc applied by hot-dip galvanizing or electro-galvanizing. Apply final coat of transparent zinc chromate to exterior. Exterior and interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking.

C. Conduits shall be available in standard trade sizes, 3/4” (21 mm) minimum.

D. Thread pitch shall conform to ANSI/ASME B1.20.1. Taper shall be 3/4”/ft (62.5 mm/m).

E. Each length of conduit shall have UL listing label.

F. In areas designated as corrosive, conduit shall meet NFPA 70.

G. Couplings, unions, and fittings: Threaded-type, galvanized steel.

H. Conduit bodies: Threaded-type, cast metal or malleable iron type with zinc or cadmium coating. Covers shall have solid gaskets and captive screw fasteners.

I. Running thread not acceptable.

2.03 RIGID METAL CONDUIT, STEEL, POLYVINYL CHLORIDE COATED (PVC-RGS)

A. Requirements of NEC article “Rigid Metal Conduit - Steel (RGS)” shall apply.

B. Coating: Apply minimum 40-mil, gray polyvinyl chloride (PVC) coating over exterior and apply urethane coating uniform and consistent to interior of conduit. Internal coating shall be nominal 2 mil thickness. Conduit having areas with thin or no coating, not acceptable. Protect conduit threads by urethane coating. PVC coating shall have been investigated by UL as providing primary corrosion protection for rigid metal conduit.

C. Fittings, and conduit bodies: Threaded type, PVC-coated. PVC coating on outside of conduit couplings shall have series of longitudinal ribs, 40 mils in thickness, to protect coating from tool damage during installation. Manufacturer of couplings, fittings, and conduit bodies shall be same as conduit manufacturer. Hazardous location fittings shall be manufactured prior to application of plastic coating, and shall be UL-listed.

D. Conduit shall meet NFPA 70 in areas designated as corrosive.

E. PVC exterior and urethane interior coatings applied to conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).

2.04 RIGID NONMETALLIC CONDUIT, POLYVINYL CHLORIDE (PVC)

A. Material: PVC Schedule 40, and Schedule 80. Schedule 40 shall be rated for underground installation; underground shall be either direct buried or encased in concrete. When encased in concrete, underground conduits shall be rated for cables operating up to 90ºC installed within.

B. Fittings, elbows, and accessories: Connect to conduit by solvent-type cement process. Material shall be same as conduit. Provide belled end fittings at each manhole and wall entrance.

C. Transition for connection of plastic conduit to rigid metal conduit shall be threadless solvent-type cement connection to PVC, with threaded connection to rigid metal conduit.

2.05 PULLBOXES AND JUNCTION BOXES

A. Where required for elbows, fittings, and accessories to be furnished by same manufacturer as conduit, boxes shall also be furnished by conduit manufacturer or by supplier approved by manufacturer.

2.06 HANDHOLES

A. Use: Airfield lighting circuits, unshielded medium-voltage circuits, and low-voltage power and communication circuits. Do not use for splicing multipair communication cables or shielded power cables.

B. Size to accommodate splices and equipment contained within handhole.

C. If acceptable to Engineer, open bottom handholes may be used.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Coordinate timing of installation and locations of raceway with other trades. Do not block access or impede construction.

B. Locations of raceway indicated on Drawings are approximate. Coordinate actual locations in field to avoid conflicts with other equipment.

C. Areas designated for, but not limited to; access, maintenance, hatchway, equipment removal, and expansion shall be kept clear of field-routed raceway.

D. Conduit embedded in concrete slabs: Minimum 1” (25 mm) from outer edge of conduit to bottom of slab. Conduit outside diameter shall be no more than 1/3 of slab thickness. Space conduits minimum of 6 conduit diameters apart.

E. Use expansion fittings where necessary. When expansion or deflection will be greater than 6” (152 mm) or greater than fitting is designed to accommodate, provide junction boxes solidly mounted on each side of expansion joint and connect with flexible, liquidtight conduit, or adjust conduit sections to limit expansion to less than 6” (152 mm).

F. Support raceway independently from equipment, and temporary or movable structures.

G. At minimum, identify raceways at both ends with raceway numbers provided by Engineer. Markers shall be adhesive, UV-resistance type with 1” (25 mm) high lettering.

3.02 USES AND LIMITATIONS

A. Refer to NEC for guidelines regarding use, and limitation of each type of conduit. Follow NEC except as specified otherwise herein, or as shown on Drawings.

B. RGS: Do not use underground except as stub-ups and apply corrosion protection. Do not mix aluminum fittings with steel conduit and vice versa.

C. PVC-RGS: May be used for conduits installed underground, direct buried, or for slab-on-grade construction. Acceptable for corrosive areas. Install conduit system in accordance with manufacturer’s installation manual. Installer shall be certified by manufacturer to install coated conduit.

D. PVC: Use Schedule 80 PVC conduit encased in concrete for installation under heavy traffic areas.

3.03 RIGID CONDUIT

A. Conduits not shown on Drawings shall be sized in accordance with NEC. Minimum size: 3/4" (19 mm).

B. Conceal conduit in finished areas.

C. Drainage: Avoid water pockets in conduit runs; provide suitable fittings at low spots in exposed conduit where pockets cannot be avoided. Weep holes not permitted in conduit.

D. Conduit ends:
   1. Cap spare conduits with fittings designed for intended use.
   2. Conduit terminating in panels or enclosures where exposed to entrance of foreign material shall be plugged with commercial duct-sealing compound around conductors.
   3. Cap conduit ends during construction to prevent entrance of foreign material.

E. Where practicable, provide 3" (75 mm) stubbed up conduit for conduit entering into bottom of freestanding equipment. Coordinate locations with equipment. Terminate with grounding bushings.

F. Clean and swab inside of conduit by mechanical means to remove foreign materials and moisture before wires or cables are installed. Cleaning method shall not damage interior surface of conduit.

G. Bushings: Provide at termination of conduit not terminated in hubs and couplings. Insulating bushings with 150˚C rated insulating inserts in metal housings shall be provided on conduit 1-1/4" (31 mm) and larger. Insulating bushings shall be grounding type. Standard bushings shall be galvanized.

H. Apply coat of zinc chromate to zinc-coated conduits where protective coating is damaged.

I. Couplings and unions:
   1. Threaded conduit couplings shall join metal conduit with conduit ends butted. Where standard threaded couplings cannot physically be used, join metal conduit using conduit unions or split couplings.
   2. Use ground-seat type, watertight unions where union may be submerged.

J. Bends: Run of conduit shall not contain more than equivalent of three 90º bends, including offsets. Use only manufacturer-approved conduit bending equipment. Do not use deformed or crushed conduits.

K. Threads: Cut ends of conduit with saw; do not use wheel cutter. Conduit end shall have same number of threads as present from factory. Apply coat of zinc chromate to steel conduit threads and apply anti-seize compound containing powdered zinc or lubricating graphite to aluminum conduit threads.

L. Use expansion joints as required such that no more than 6" (152 mm) allowance for expansion or contraction of conduit occurs.

3.04 CONDUIT SUPPORTS

A. Supports of structural steel or manufactured framing members shall be fabricated from lightweight channel approved by manufacturer for intended use, provide required rods, anchors, inserts, clamps, spacers, shims, bolts and accessories.

B. Clamps: Galvanized malleable iron 1-hole straps, beam clamps, or other device with necessary bolts and expansion shields.

C. Adjustable hangers: Use to support horizontal runs only. Use trapeze-type supports for parallel runs of conduit. Install U-bolts at end of each run and at each elbow. Install conduit clamps every third intermediate hanger for each conduit. Hanger rods shall be 3/8” (10 mm) minimum diameter threaded galvanized steel rods.

D. Conduits supports mounted on concrete surfaces: Fasten with self-drilling tubular expansion shell anchors with externally split expansion shells, single cone expanders, and annular break-off grooved chucking cones.

3.05 PENETRATIONS

A. Provide required penetrations in floors and walls. Penetrations shall be kept to minimum, as small as possible, and installed in neat manner. Surrounding surfaces damaged during installation of penetrations shall be included as part of this work.

B. Seal penetrations in floors and enclosures. Provide fire stops for electrical raceway penetrations. Maintain original fire rating that existed prior to commencement of work. Do not install fire seal for wire openings until interconnecting wiring of equipment is proven to operate properly.

C. Sleeves:
1. Provide for passage of conduits through walls, floors, or partitions. Set sleeves in masonry during construction; set sleeves through concrete before placement begins.
2. Material: Rigid conduit or pipe securely fastened in position.
3. Cut sleeve flush with floor where conduit enters equipment enclosure otherwise extend sleeve 3” (75 mm) above floor.
4. Sleeves through exterior building walls: Install conduit in center of sleeve. Pack interior and exterior annular space around conduit with plastic backer rod sized to fit annular space in compression as recommended by backing manufacturer. Seal interior and exterior of joint with acrylic polymer sealant.
5. Sleeves through waterproof construction shall be flanged type.

D. Penetrations required after footings, walls, or floors are constructed shall be provided and grouted or sealed. Openings shall be core-drilled, do not jackhammer.

E. Patch and finish openings made in existing walls and floors to match original material in composition and appearance.

3.06 CONDUIT INSTALLED UNDERGROUND

A. Direct-buried conduit:
1. Direct-buried, underground or below slab conduit shall be RNMC unless indicated otherwise and installed to yield completely corrosion protected conduit system.
2. Slope conduits for drainage.
3. Depth: Minimum as required by NEC.

B. Plastic-coated, rigid steel conduit:
1. Use procedures recommended by manufacturer to prevent damage to PVC coating.
2. Use strap wrenches for tightening threaded joints.
3. If protective coating is damaged, repair by application of patching compound as recommended by manufacturer.

C. Concrete encased underground duct may be Type EB, unless noted otherwise. Verify by calculation that hydraulic force on bottom duct does not exceed theoretical collapse pressure of duct. Use thicker wall duct as required, unless a sequential pour technique is used.

D. Elbow that stubs up at end of a conduit run shall be RGS conduit and shall be bonded to grounding system. Provide required fittings and accessories for connection of RGS conduit to nonmetallic conduit.

E. Install duct runs and manholes at elevations consistent with project requirements. Top of duct banks shall be not less than 30” (750 mm) below finished grade elevation, unless indicated otherwise. Provide extension rings on manholes as required to bring opening flush with finished surface.

F. Utilize duct spacers, both vertically and horizontally, to support runs of concrete encased ducts. Install duct spacers 8’ (2.4 m) maximum on center, unless specified otherwise. Brace duct runs during concrete placement to prevent floating. Wood spacers or braces in concrete encasement are not acceptable, and iron ties or straps shall not be used around single ducts, but may be used around whole duct run.

G. Crown duct runs between manholes at midpoint of run to allow drainage back into manholes. Slope shall be minimum of 1/32” per foot (0.8 mm per meter) of slope. Duct runs from stub-ups back to manholes shall maintain same slope. Provide end bell fittings at terminations of conduits into manholes.

H. Install ground cable and connect to ground system on both ends of duct bank. Place ground cable in concrete, and above direct buried conduits.

I. Concrete work:
   1. Duct bank concrete shall be poured without forming, provided trench walls do not cave; otherwise, use forms. Make trench no wider than necessary to provide nominal size concrete thickness.
   2. Tie down conduits to prevent floating during concrete pouring.
   3. Remove foreign substances from conduits before pouring concrete.
   4. Use splashboard to divert flow of concrete away from trench sides, and avoid dislodging soil and stones. Prevent loose excavated material from falling into trench during concrete pouring.
   5. Pour each section of duct bank complete in one operation; if this is not feasible, provide construction joint using rigid steel conduit 5’ (1.5 m) on each side of joint.
   6. Begin concrete pouring at 1 end of duct bank, working toward other end, to allow free end to move. Do not pour concrete from each end toward center.
   7. Do not use mechanical vibrators.
   8. Provide red coloring in concrete.

J. Adjust duct footage at each tie-in to account for expansion and contraction due to variations in temperature anticipated during installation. Backfill terminated duct runs from tie-in point toward other end. If trench must be left open, do not terminate run. Consult with manufacturer for coefficient of thermal expansion properties.

K. Use expansion joints as required such that no more than 6” (150 mm) allowance for expansion or contraction of conduit occurs.

L. After construction of duct bank is complete, pull mandrel through each duct. Mandrel shall be 1/4” (6 mm) smaller in diameter than duct. If obstruction is encountered, or if there is evidence of water pocket, that section of duct bank shall be located, removed, and rebuilt with no schedule delay and additional cost to Owner.

M. Underground utility marking tape for below grade raceway systems:
   1. Provide solid aluminum foil core tapes for protection, location, and identification of underground utility installations.
   2. Meet or exceed industry standards for APWA color code.
   3. Resist degradation from acids and alkalis found in soil.
   4. Contain environmentally safe lead-free pigments and organic lead-free ink identifying type of utility line it protects.
   5. Provide width of tape appropriate for detection of conduit at required depth of installation.

N. Support wireways and boxes independently of conduits by means of bolts, screws, rod hangers, and other suitable means.

3.07 HANDHOLES

A. Install in accordance with manufacturer's instructions.

B. Remove material as required for proper alignment and elevation of work. Backfill and grade area to match final grade elevations.

C. Provide extension rings as required to meet final finished elevations.

END OF SECTION

1) B. A. Wachtel
2) L. E. Ingram

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Natural gas generator set work as indicated by Drawings; indicating ratings, locations of equipment and other features of a system.

B. Generator set ancillary work includes following:
1. Combustion air-intake system.
2. Engine exhaust system.
3. Starting system with batteries and charger.
4. Cooling system.
5. Instrumentation, protection and control equipment.
6. Acoustic treatment.
7. Cabling and wiring.
8. Grounding to nearest main ground ring.

C. Coordinate work between civil and electrical work for best results.

D. Vibration control for natural gas engine-driven generator unit shall include pads, springs, rails, bases, hangers, and connectors. Ensure provision of appropriate components.

E. Refer to Division 20 for piping and associated accessories required for installation of natural gas engine-generator units.

1.02 RELATED REQUIREMENTS

A. This specification shall comply with latest ADWEA/ADDC specifications. Where conflicts arise, ADWEA/ADDC specification shall govern.

1.03 INFORMATIONAL SUBMITTALS

A. Product Data: Submit full technical data of equipment for evaluation and approval including, but not limited to, following:
1. General description and characteristics of engine- generating sets, standards with which components Comply, site rating and overload capability, overall efficiency, and fuel and lubricant consumption at 100%, 75%, 50% and 25% of rated load, number of cylinders, bore, stroke, displacement, compression Ratio, piston speed and break mean effective pressure (BMEP).
2. Description and operating criteria of engine; type, model, manufacturer, fuel and lubricating oil types and Specific consumption, starting conditions and starting periods from cold to full-load pick-up, governor And Response characteristics due to sudden load changes, super-charger, fuel injection system, cooling system and radiator, air filters, fuel filters, oil filters and pumps.
3. Description and operating criteria of generator, exciter and voltage regulator, with loading response and short-circuit characteristics, insulation, cooling and accessories.
4. Dimensions, weights and forces, mounting methods, vibration protection etc.
5. Battery type, make, charge/discharge characteristics, capacity and constructional features.
6. Battery charger, method of charging, equalizing and trickle charging.
7. Exhaust system and silencers; materials and construction.
8. Control instruments, protection, alarms, cut-outs, indicating lamps, indicating instruments and all other devices or components.
9. Calculation for net site rating of generator after deduction of all auxiliaries and application of efficiencies and de-rating factors including (temperature, altitude, and humidity).
10. Calculated noise levels in dBA at typical points within engine area and at various locations inside and outside.
11. Provide list of manufacturer's spare parts for 2000 hours operation together with current prices.
12. Provide list of tools and instruments required for normal routine inspection, testing, operation and general maintenance, as recommended by manufacturer, together with current prices.

B. Quality assurance data:
   1. Compliance: Submit clause-by-clause compliance statement with specification.
   2. Certifications: Provide natural gas engine-driven generator sets certified test record as required under "Source Quality Control" and with no limitation to, is to include following final production testing:
      a. Single-step load pickup.
      b. Transient and steady-state governing.
      c. Safety shutdown device testing.
      d. Voltage regulation.
      e. Rated power.
      f. Maximum power.
   3. Local representative: Provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy Engineer may disqualify a manufacturer.
   4. Agreement to maintain: Prior to time of final acceptance, Contractor shall submit 4 copies of an Agreement for continued service and maintenance of natural gas engine-driven generator sets, for Owner's possible acceptance. Offer terms and conditions for furnishing parts and providing continued testing and servicing, including replacement of materials and equipment, for one-year period with option for renewal of Agreement by Owner.

1.04 ACTION SUBMITTALS

A. Shop Drawings:
   1. Layout drawings of natural gas engine-driven generator units and accessories including, but not limited to, plans and elevations, automatic transfer switches and inter-cabling, fuel line piping, remote start-stop stations, and instrumentation, exhaust ducting and fresh-air ducting. In addition, show natural gas generator set units and their spatial relationship to associated equipment. Allow adequate clearance space for removal of engine generator elements for maintenance purposes.
   2. Wiring diagrams for natural gas engine- driven generator units showing connections to electrical power panels, feeders, output or transfer switchgear, and ancillary equipment. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

1.05 MAINTENANCE MATERIALS

A. Provide manufacturer's recommended spare parts for 2,000 hours operation of standby plant.

1.06 QUALITY ASSURANCE

A. Manufacturer's qualifications: firms regularly engaged in manufacture of natural gas engine-driven generator units and ancillary equipment, of types, ratings and characteristics required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer's qualifications: firm with at least 3 years of successful installation experience on projects with natural gas engine-driven generator units similar to that required for this project.

C. Agreement to Maintain: Engage Installer who is willing to execute with Owner, required agreement for continued maintenance of natural gas engine-driven generator units.

D. Regulatory requirements:
   1. Standards: Equipment and component parts are to comply with ISO 3046, ISO 8528, IEC 60034, IEC 60085 and CISPR, or equivalent NEMA, ANSI, IEEE and DIN Standards and recommendations of ABGSM (Association of British Set Manufacturers) where such standards meet with or supersede ISO and IEC Standards.
   2. Electrical Code Compliance: Comply with applicable local code requirements of authority having jurisdiction pertaining to construction and installation of emergency and standby systems.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver natural gas engine-driven generators properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for engine-generator and components, which protect equipment from damage.

B. Store natural gas engine-driven generator equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle natural gas engine-driven generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.08 WARRANTY

A. Provide manufacturer's standard product warranty, for duration of not less than 1-year, for replacement of defective materials and equipment used in natural gas generator systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering natural gas generator sets for standard generator sets, which may be incorporated in work, include, but are not limited to, following:
1. Caterpillar (U.S.A.).
2. Cummins/Onan (England/U.S.A).
3. Deutz (Germany).
4. MAN (Germany).
5. Komatsu (Japan).
6. Mitsubishi (Japan).
7. Petbow (UK).
8. F.G.Wilson (UK).
9. Stewart and Stevenson (USA).
10. Or equal.

2.02 NATURAL GAS GENERATOR SET

A. Generator set assembly: Compact package type, with all equipment mounted on one rigid steel bed frame suitable for skidding. Radiator shall be mounted on set. Design is to permit easy operation, maintenance and repair.

B. Vibration reduction shall be achieved by appropriate design and careful balancing at factory. Weight of inertia base shall be 1 to 2 times generator weight. Type, quantity location and arrangement of inertia base’s spring isolators shall be selected and sized according to generator weight, central of gravity and excitation frequency range in order to ensure a minimum isolation efficiency of 98% at lowest operating speed. Springs shall be chosen to have a natural frequency of 1/10 that of lowest operating speed under combined load of base and generator set. Inertia base shall be provided with adequate amount of reinforcing steel bars and with a suitable number of spring isolators in order to achieve a maximum inertia base depth of 15 cm for generator. Inertia base works are to include all necessary coordination with generator manufacturer and with structural works for generator’s installation and mounting requirements and locations of anchoring devices. Inertia base frame and spring isolators shall be obtained from Kinetics Noise Control of USA or other equal and approved manufacturers.

C. Noise reduction shall be achieved by approved methods at source of noise, noise level and treatment shall be an essential factor in generator evaluation.

D. Cold Starting: Engine shall be fully equipped to start and pick up initial load specified at specified minimum ambient temperature. Cold starting aids, such as engine jacket water heater, lubricating oil heater, lubricating oil circulation intake-air heater, oversize standby battery and all devices,

accessories, connections, thermostatic switches and off-duty disconnects with pilot lights and necessary protection, shall be supplemented as recommended by manufacturer.

E. Equipment ratings: As shown on Drawings or next higher standard ratings provided by manufacturer. Ratings shall be net continuous output to consumer, excluding fan and any auxiliaries, auxiliary drives and losses, delivered at specified frequency, voltage and power factor and under worst climatic conditions on site.

F. Insulation Class: Class “H”.

G. Components: Set shall basically consist of natural gas engine, brushless synchronous generator with direct flexible coupling to engine and single or parallel control cubicle as required.

H. Governing: ISO 3046/IV or BS 5514, using electronic type governor with limits of speed control as specified.

I. Starting and stopping: When in “Automatic” mode set shall to start and stop automatically by signal sensed through auxiliary contact in load transfer switchgear. Set shall stop after adjustable cool-down period (2 - 30 minutes).

J. Duty: Generators to reach full speed within 10 seconds from start impulse and accept immediately 60% of net rated output (load being mixed, steady and inductive, with motor starting loads as shown on Drawings). Transient voltage variation is not to exceed 15% under 60% step-load application for which system is intended, up to full rated load, recovering to within +/-2% within a few cycles.

K. Failure to start: Should engine fail to start following a start impulse, system is to come to rest for a few seconds. Two further starting attempts shall be automatically made with intermediate 20 second maximum periods of rest. Should set fail to start after three attempts, an alarm is to sound and a 'start failure' signal illuminate.

L. Hand operation shall be possible for testing or normal operation through a test/manual/off/auto selector switch.

M. Regular exercising: While on 'Auto', set shall start regularly and automatically every week and shall operate for 30 minutes before stopping.

2.03 NATURAL GAS ENGINE AND AUXILIARIES

A. Design natural gas engine for type of load and application required. Engine and governor shall be selected to meet operating requirements and response specified.

B. Engine: Engine shall operate on natural gas. Engine shall be standard production model shown in manufacturer’s catalog describing and depicting each engine-generator set and all ancillary equipment in sufficient detail to demonstrate complete specification compliance. Engine shall be naturally aspirated, supercharged, or turbocharged. Engine shall be stroke-cycle and compression-ignition type. Engine shall be vertical in-line, V- or opposed-pision type, with solid cast block or individually cast cylinders. Engine shall have minimum of 12 cylinders. Opposed-piston type engines shall have not less than four cylinders. Each block shall have coolant drain port. Each engine shall be equipped with an overspeed sensor. Total engine displacement shall be greater than or equal to 52L and have minimum of 12 cylinders.

C. Generator Ratings: As shown on Drawings or next higher standard ratings provided by manufacturers. Ratings shall be standby power with limited time running hours (LTP) to ISO 8528-1, net to consumer excluding fan, auxiliaries, losses, etc., delivered at specified voltage, frequency and power factor and under worst climatic conditions on site.

D. Grounding: Generator neutral to be resistance grounded. Neutral resistor shall be sized such that line-to-ground fault current does not exceed 1-phase fault current.

E. For accessibility, it shall be possible to:
   1. Remove rocker-box covers without disturbing fuel injection pipes or other components.
   2. Remove and replace pistons and piston rods, liners, big and small end shells and caps without dismounting engine.
   3. Bar engine over by hand for spill timing check and adjustment.

F. Measuring Instruments: Engine-mounted instruments shall include, at least, water temperature gauge, lubricating oil temperature gauge and pressure gauge, tachometer and running time meter. It shall be possible to measure, with extra instrumentation, coolant temperature at lower end of radiator, air depression after air filter, air boost and temperature using methods recommended by manufacturer. Instrument accesses shall be normally sealed by threaded blanking caps.

G. Cooling system: Engine shall be water cooled with gear- driven water pumps. System shall be pressurised, with heavy duty tropical radiator cooled by reverse flow fan. Fan cowl and hand protection guard shall be fitted. Coolant temperature shall be controlled by one or more thermostats as determined by design of system. Radiator shall be sized for continuous performance at 110% rated load at worst operating ambient conditions with a 15°C temperature differential. Radiator shall be nonferrous metal, incorporating pressure valve, radiator cap and drain cock and with integral expansion tank. Direct acting modulating thermostatic diversion valve is to control engine cooling water temperature. Under normal operation, by-pass is not to be fully closed. Treated or fresh cooling water and anti-corrosion and anti-freeze additives shall be used as recommended by manufacturer for specific conditions of installation.

H. Cooling airflow: Obstructions in path of cooling air flow (openings, louvers, grilles, mesh, ducts, bends etc.) are not to reduce air flow below that needed at full rated output. Fan and radiator characteristics shall be selected accordingly. Advise if additional booster fans are required and provide necessary control gear for automatic operation.

I. Cylinders shall have removable liners. Wet type liners shall have witness hole between liner sealing rings of each cylinder for early detection of coolant or oil leakage. Each cylinder shall have drilled and tapped hole and valve for connections of pressure indicator.

J. Lubricating oil system: Pressurized circulating type, using 2 engine-driven, gear type lubricating oil pumps with full flow filters and replaceable elements and lubricating oil heat exchanger. Filter system shall have spring loaded by-pass valve to permit oil circulation if filters become clogged. Audible and visual alarms shall cut-in when valve starts opening. Lubricating oil cooler shall be shell and tube heat exchanger with water from engine radiator as cooling medium. Direct acting thermostatic diversion valve shall control oil temperature. Under normal operation by-pass is not to be fully closed.

K. Gas fuel train shall be designed, sourced and shipped by genset manufacturer along with the genset. Designed for installation just upstream of engine fuel inlet. Shall be capable to handle gas supply pressures from 4.9 to 18.9 kPa (0.65 to 2.6 psi) at gas train inlet. Maximum pressure drop across gas train at full rated flow, with a new filers: 1.03 kPa (0.14 psi). Inlet connection size: DN125. Minimum gas train outlet pressure: 344 kPa (0.5 psi). Gas train shall include the following components:
   1. Manual shutoff valve.
   2. Electronic gas shutoff valve: 24V DC, energized-to-run, double solenoid with visual position indicators.
   3. Fuel filter: 96 percent efficiency at 1 micron particle size, shall include differential pressure gauges.
   4. Gas pressure regulator.
   5. Connection to engine fuel inlet: Flexible, braided hose.
   6. Outlet connection: ASME/ANSI B16.5 Class 150, type (3-).
   7. Gas train pressure sensors: 4-20 mA, 0-100 kPag, installed in the gas train with 1/2" (13 mm) NPT conduit.
   8. Two sensors installed shall provide differential filter pressure.
   9. One sensor installed shall provide post regulator engine fuel inlet pressure.

L. Exhaust system shall be complete with flanged, bolted, galvanised, seamless steel pipe sections, long sweep elbows, flexible expansion sections, clean-outs, residential silencer, wall thimbles and supporting steelwork. Silencer shall be supported by generator. Indoor hot exhaust parts shall be

insulated with fibreglass tape, not less than 10 mm thick, with anti-condensation overlap and sheet metal covers to protect insulation. Exhaust system shall be designed to reduce back pressure to below maximum specified by manufacturer, in relation to exhaust pipe.

M. Air intake system: Engine air filter shall be either dry filter with replaceable paper filter elements. Filters shall be capable of removing particles 10 microns and larger.

N. Electric starting system: engine starting shall be manual by pushbutton or automatic through control system at control panel. System is to consist of heavy duty 24 volts dc. starter motor, heavy duty battery and battery charger. Cranking motor and battery shall be rated for cranking engine when cold and at lowest temperature recorded. Starting pinion is to automatically disengage when engine fires.

O. Storage battery: lead-acid, sealed-in-plastic type, complete with battery rack and inter cell connectors. Battery shall have sufficient capacity to provide minimum 4 cranking periods.

P. Battery charger: to be 25% over-rated, solid state, full-wave rectifier type, adequate to fully recharge depleted battery in not more than 8 hours and to automatically control rate of charge (providing a high-charge rate to a depleted battery and reducing to a trickle-charge rate when battery is fully charged). Ammeter shall be provided to indicate charging rate, which shall be adjustable. Battery charger shall be mounted in control cubicle.

Q. Electronic governor shall provide isochronous governing, paralleling and load sharing of generator sets. Governor shall have 0% (isochronous) setting and adjustable droop from 0% to 10% droop. System is to include power supply unit, magnetic speed pick-up, control module and actuator using fast response dc. motor drive or equally approved alternative. Governor shall be designed for fast-response and high-precision of speed (frequency) control, automatic paralleling (in future) and load-sharing and is to include speed adjustment to +/-5% of normal, while running, and with remote control interface. Frequency deviation under 25% sudden load change is not to exceed 0.5 Hz, recovering to stable speed condition of +/-0.1 Hz in 0.5 seconds.

R. Governor over speed trip shall automatically close fuel pump racks in event of engine over speed. Device shall be separate and independent from governing mechanism.

S. Protective system shall comprise automatic engine shut- down and generator trip with visual and audible alarm in event of over speed, low lubricating oil pressure, high cooling water temperature and over cranking.

2.04 GENERATOR EXCITER AND VOLTAGE REGULATOR

A. Synchronous, low reactance, high efficiency, revolving field type, with brushless exciter and flexible coupling, sized to pick up effective load without exceeding transient and steady-state voltage deviation limits specified up to its full nominal rating and designed for performance stipulated in Specification. Bearings shall be of sleeve or sealed ball type.

B. Leads and cables: Phase leads shall be brought out fully insulated to a terminal cable box of heavy-gage sheet steel, protection IP 54. Control and protection cables shall be brought out to a separate terminal box.

C. Maximum voltage difference between three phases at 100% balanced load is not to exceed 1%. With unbalanced load up to 30% on one phase at unity power factor and zero load on other phases, line-to-neutral voltages are not to differ by more than 5%.

D. Characteristics:
1. Number of phases: 1.
2. rated voltage, frequency, and net rated output: As shown on Drawings.
3. Rated power factor: 0.8.
4. Winding connection: Reconnectable with ends brought out and fully insulated maximum unbalanced load current, (negative sequence component of current) with none of phase currents exceeding rated.
5. Current: 8% of rated current.
6. Maintained short circuit : 250% for 3 seconds.
7. Over-speed: 120% minimum for 2 minutes.

8. Rotor: Salient pole type, incorporating damping grid.
9. Excitation: Brushless, with rotating armature rectifiers and discharge resistors.
10. Voltage regulator: Automatic, with readily accessible controls for voltage level.
11. Insulation: Class H for stator, Class H for rotor and exciter with Class F (105ºC) maximum winding temperature rise.
12. Enclosure: Dripproof and screen protected (IP 54 minimum to IEC 144).
13. Cooling: Built-in centrifugal fans.

E. Voltage regulation: Overall voltage deviation within normal speed variations shall be within limits specified from no-load to full-load, from hot to cold and with load power factor from 0.8 lagging to unity. Regulator is to automatically reduce voltage if load exceeds capacity of generator. Voltage build-up shall be positive and rapid even when full load is suddenly applied. Line-to-line voltage wave-form deviation factor is not to exceed +/-5%. Total harmonic content is not to exceed 5% and that of one harmonic not to exceed 2%. Radio interference suppression shall be within limits set by Standards, grade (N).

F. Exciter: Armature shall be 1-phase, directly mounted to generator shaft and connected to generator field windings through two solid state, hermetically sealed, silicon rectifiers, accessible for maintenance or repair. Exciter shall have field suppression system to eliminate any source of diode failure resulting from high inductive loads and surges. Exciter field windings shall be stationary. Exciter-regulator combination is to maintain output voltage within limits specified for any load up to full generator rating and under any sudden load changes specified.

G. Voltage regulator: Solid state, volts/Hz type, utilizing silicon semi-conductor devices in control and power stages, with built-in electro-magnetic interference suppression and designed for single or parallel operation. Manual adjustment to +/-5% of regulated voltage level shall be possible by a potentiometer at control panel. All components shall be sealed, moisture and heat resistant, with a suitable environmentally protected enclosure. Voltage regulator is to automatically reduce voltage if load exceeds capacity of generator and is to sustain a 1-phase short- circuit current at generator terminals for period for which short-circuit protection operates and at least for 3 seconds. Voltage regulator power shall be supported by generator voltage and current to maintain excitation field power.

H. Two position switch shall be provided for selection of manual or automatic mode of regulated voltage control.

2.05 INSTRUMENTATION, PROTECTION AND CONTROL EQUIPMENT

A. Generating Set Instruments, Protection and Controls: Control relays, sensing equipment, switchgear protective relays and devices and start, stop and shutdown controls shall be provided as necessary for operation specified. Generating set, instruments, protection and controls shall be mounted preferably in one control cubicle. Generator controls, metering and monitoring shall be carried out via solid state, microprocessor based modular controller.

B. Instruments and controls are to include at least following:
1. Line and phase voltage metering
2. Current metering.
3. Frequency metering.
4. Off/test/manual/auto duty switch.
5. Manual start and stop push buttons.
6. Kilowatt-hour metering.
7. Power factor metering.
8. Service hour running counter.
9. Plant exerciser.
10. Programmable solid state monitoring unit (s)may be provided instead of analogue devices, subject to Engineer’s approval.
11. Potentiometer for voltage level control.
12. Speed raise/lower device.
13. Cool-down time setting controls.
14. Illuminated indicator panel with LEDs at least for low oil pressure, high water temperature, over speed, fail-to-start, over-crank, generator on load, generator off load, generator over load, battery low charge state.
15. Lamp test pushbutton.

16. Indicating gauge and low level fuel alarm.
17. Battery charger, on/off switch, pilot lights.
18. DC ammeter.
19. Alarm sounder and reset controls.
20. Anti-condensation heater.

C. Protective gear is to ensure orderly engine stop or shutdown with reset relays, as required for safety and operational reliability, and is to include following:
   1. Output for over-current and external earth fault protection.
   2. Circuit breaker, electrically and manually operated with solid-state trip
   3. Over-voltage protection with voltage and time lag adjustment.
   4. Loss-of-field protection.
   5. Negative phase sequence protection.
   6. Restricted earth fault protection with current adjustable between 0 and 20% of rated current, and time adjustable setting 0 to 3 seconds.

2.06 CONTROL AND PROTECTIVE GEAR CUBICLES

A. Generator set mounted instrument and/or control cubicles shall be resiliently mounted, preventing transmission of vibration to components. Separately mounted instrument and control cubicles shall be self-supporting, floor mounted and free- standing. Cubicles shall be sheet steel construction, ventilated indoor type, vermin and dust-proof, (IP 42 to IEC 529), with lockable hinged doors and instrument panels, separate compartments for control devices, protective relays, circuit breaker(s) and neutral earthing device. Inner and outer surfaces of steel enclosures shall be cleaned, phosphatized, primed with heavy duty rust inhibiting primer and finished with two coats of enamel. Wiring shall be 600 V, modularly arranged, with connections made at front terminal blocks with no live conductors exposed. Wires shall have approved numbered ferrules at each terminal. Printed circuit plug-in boards, where applicable, shall be of industry standards, accessible and withdraw able, mounted in standard racks.

B. Relays: front adjustable, electronic, solid state sealed type, with dust-tight enclosures, removable covers, test terminal blocks and plugs for testing relay without removal from case. Removal from casing is to automatically short-circuit respective current transformer secondary windings.

C. Instruments shall be housed in enamelled metal cases for switchboard flush installation, with scales and markings protected and sealed. Indicating meters shall be minimum 76 mm square. Accuracy shall be within 2% unless otherwise specified. Voltmeters and ammeters shall be moving iron type for ac measurements and moving coil type for dc measurements.

D. Current Transformers: Class 2 for measuring and protection.

E. Voltage Transformers: Single phase, dry type, 0.5 accuracy class.

F. kWH Meter: Single phase multi-function meter.

2.07 MISCELLANEOUS REQUIREMENTS

A. Finishes, indoor enclosures and components: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

B. Acoustic inlet and outlet attenuators: Fit within frame and based on 100 mm airways with 200 mm acoustic modules. Fit attenuators with weather louvers. Noise level shall be not more than 85 db(A) at one meter.

2.08 SOURCE QUALITY CONTROL

A. Factory tests: include prototype testing and Project-specific equipment tests (equipment manufactured specifically for this Project).

B. Prototype testing: performed on a separate engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: conform to those required as per specifications.
2. Components and Accessories: items furnished with installed unit that are not identical to those on tested prototype have been acceptably tested to demonstrate compatibility and reliability.

C. Project-specific equipment tests: test engine generator set and other system components and accessories prior to shipment. Test items individually and assembled and connected as a complete system at factory in a manner equivalent to that required at Project site. Record and report test data.
1. Test equipment: use instruments calibrated within previous 12 months.
2. Hydrostatic test: perform on radiator, heat exchanger, and engine water jacket.
3. Generator tests: conform to IEC/ISO.
4. Complete system continuous operation test: includes nonstop operation for a minimum of 8 hours, including at least 1 hour each at 1/2, 3/4, and full load. If unit stops during 8-hour test, repeat complete test. Record following minimum data at start and end of each load run, at 15-minute intervals between those times, and at 15-minute intervals during balance of test:
   a. Fuel consumption.
   b. Exhaust temperature.
   c. Jacket water temperature.
   d. Lubricating oil temperature and pressure.
   e. Generator load current and voltage, each phase.
   f. Generator system gross and net output kW.
5. Complete system performance tests: Include following to demonstrate conformance to specified performance requirements.
   a. Single-step load pickup.
   b. Transient and steady-state governing.
   c. Transient and steady-state voltage performance.
   d. Safety shutdown devices.
6. Observation of Test: provide 2-week advance notice of tests and opportunity for observation of test by Owner's representatives.
7. Report test results within 10 days of completion of test.

PART 3 EXECUTION

3.01 INSTALLATION

A. Anchor generator set and other system components on concrete bases. Provide anchorage according to manufacturer's recommendations.

B. Field installation of piping: as specified in Division 20.

C. Exhaust piping installation: Conform to Standards approved for project. Use thimbles where required.

D. Maintain minimum working space around components according to manufacturer's shop drawings applicable codes.

3.02 MANUFACTURER'S FIELD SERVICES

A. Arrange and pay for services of a factory-authorized service representative to supervise installing, connecting, testing, and adjusting of unit.

3.03 FIELD QUALITY CONTROL

A. Supervised adjusting and pretesting: Under supervision of factory-authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Provide load system using variable resistive and reactive load bank during testing only simulating kW and power factor of loads for which unit is rated.

B. Tests: provide services of a qualified independent testing agency to perform tests listed below according to manufacturer's recommendations upon completion of installation of system. Use

instruments bearing records of calibration within last 12 months, traceable to approved standards, and adequate for making positive observation of test results. Include following tests:

1. Insulation Tests: test generator windings using 500 volts dc for units rated up to 250 volts and 1000 volts dc. for units rated between 250 and 600 volts. Verify minimum insulation resistance is 25 megaohms for units up to 250 volts, and 100 megaohms for units 251 to 600 volts. Verify by dielectric absorption test that polarization index levels are according to manufacturer's industry standards approved
2. Battery tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
3. Battery charger tests: Verify specified rates of charge for both equalizing and float-charging conditions.
4. System integrity tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
5. Simulation of malfunctions to verify proper operation of local protective, alarm, and monitoring devices.
6. Load Test: Use variable load bank capable of simulating kVA, kW, and power factor of load for which unit is rated. Run unit at 25%, 50%, and 75% of rated capacity for 30 minutes each, and at 100% for 3 hours. Make 100% load run at 80% power factor. Record voltage, frequency, load current, battery-charging current, power output, oil pressure, and coolant temperature periodically during test.
7. Vibration baseline test: Measure amplitude for nominal frequency and for frequencies 5%, 10%, 15%, and 20% above and below nominal at each main bearing cap. Vibration levels not exceeding those specified in NEMA MG1, "Motors and Generators," are acceptable.
8. Exhaust system back-pressure test: Use a manometer with a scale exceeding 40” (1m) of water. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's published allowable limits for engine.
9. Exhaust emissions test: Conform to applicable government test criteria.
10. Voltage and frequency transient stability tests: Use recording oscilloscope to measure voltage and frequency transients for 50% and 100% step-load increases and decreases and verify that performance is as specified.
11. Harmonic content tests: Measure harmonic content of input and output current under 25% and at 100% of rated linear load. Verify that harmonic content is within specified limits.
12. Efficiency tests: Perkaform at 50%, 75%, and 100% of rated load.

C. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.04 CLEANING

A. Upon completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.05 DEMONSTRATION

A. Training: Arrange and pay for services of a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of system and to train Owner's personnel.

B. Conduct minimum of 8 hours of training.

C. Schedule training with at least 7-day advance notice.

3.06 COMMISSIONING

A. Battery equalization: Equalize charging of battery cells according to manufacturer's instructions. Record individual cell voltages.

END OF SECTION

1) B. A. Wachtel
2) L. E. Ingram

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Microprocessor-based logic bypass isolation automatic transfer switches (ATS).

1.02 WORK BY OTHERS

A. Receiving, unloading, and storage.

B. Final placement.

1.03 INFORMATIONAL SUBMITTALS

A. Submit with Bid:
1. Completed Data Sheets.
2. Ratings and nameplate information.
3. Elevation and outline drawings with dimensions.
4. Component and accessories list.

B. Quality assurance data: Certified test reports.

1.04 ACTION SUBMITTALS

A. Product Data:
1. Nameplate schedule.
2. Component list.

B. Shop Drawings:
1. Certified complete and accurate Data Sheets.
2. Master drawing index
3. Front view and plan view of assembly.
4. Schematic diagrams.
5. Conduit space locations within assembly.
6. Assembly ratings including:
   a. Short-circuit rating.
   b. Voltage.
   c. Continuous current rating.
7. Major component ratings including:
   a. Voltage.
   b. Continuous current rating.
   c. Interrupting ratings.
8. Cable terminal sizes.
9. Where applicable, submit following additional information:
   a. Busway connection.
   b. Connection details between close-coupled assemblies.
   c. Composite front view and plan view of close-coupled assemblies.
   d. Key interlock schematic drawing and sequence of operations.
   e. Mimic bus.

1.05 CLOSEOUT SUBMITTALS

A. Record Documents:
1. Final Record Drawings and information for items submitted for review.
2. Internal wiring diagrams.
3. Certified production test reports.
4. Installation information.

5. Seismic certification.
6. Component and accessories list.
7. Receiving, storage, installation, and testing instructions.
8. Warranty data.

B. Operation and maintenance manuals: Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for complete assembly and each major component.

1.06 QUALITY ASSURANCE

A. Manufacturer's qualifications:
1. Manufacturer of major components within assembly.
2. ISO 9001 certified.
3. Manufacturer of equipment shall have produced similar electrical equipment for a minimum period of 5 years.
4. When requested by Engineer, provide acceptable list of similar equipment installations complying with requirements of this specification.

B. Regulatory requirements: Design, manufacture, and test in accordance with:
1. ANSI C37.90.
2. CISPR 11.
3. FCC Part 15, Subpart B, Class A.
4. IEC 801-2, 3, 4, and 5.
5. IEEE 446.
6. NEMA ICS10.
7. NFPA 70, 99, 110.
8. UL 991.
9. UL 1008.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handle and store in accordance with manufacturer's instructions. Provide 1 copy of instructions with equipment at time of shipment.

B. During delivery, handle equipment to prevent damage, denting, or scoring.

C. Store equipment and components in clean, dry place. Protect from weather, dirt, water, construction debris, and physical damage in accordance with manufacturer's instructions.

D. Space heaters shall be connected to temporary source of power and shall be monitored.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Ambient Conditions: See Data Sheets

B. Design equipment in accordance with the relevant sections of the most recent local Building Code.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide automatic transfer switch that will initiate signal on power failure and automatically detect secondary power source, transferring load to secondary source.

B. On restoration of primary power, switch shall automatically transfer back to primary power.

C. Signal shall be available to shut down secondary source.

2.02 RATINGS

A. 100% equipment rated for continuous duty conforming to applicable requirements of UL 1008 for emergency system total load.

B. Refer to Data Sheets.

C. Transfer switches rated 800 amperes and above shall have minimum 60-cycle withstand rating of 51 kA.

D. Switch shall be rated for application with upstream power circuit breakers and insulated case circuit breakers having short-time delay settings of up to 30 cycles.

E. Voltage rating: No less than system voltage rating.

F. Continuous current rating: No less than maximum continuous current requirements of system.

G. Fully rated to protect all types of loads, inductive and resistive, from loss of continuity of power, without derating, either open or enclosed.

H. Contacts shall not weld when used with upstream overcurrent protective devices that do not incorporate instantaneous trip units.

2.03 CONSTRUCTION

A. Switching panel shall consist of completely enclosed contact assemblies and separate control logic panel.

B. Control power for transfer operations shall be derived from line-side of source to which load is being transferred.

C. Each transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation.

D. Main contacts shall be mechanically locked in position in both normal and emergency positions.

E. Neutral position shall not be possible under normal electrical operation unless delayed transition accessory is required for switching highly inductive loads.

F. Operations:
   1. Transfer switches shall be capable of being operated manually under full rated load conditions.
   2. Manual operation shall be accomplished by a permanently attached manual operator, or by integrally mounted pushbuttons.
   3. Removable manual operating handles and handles that may move in event of electrical operation during manual operation not acceptable.
   4. Manual operators requiring source or load disconnection prior to manual operation not acceptable.

G. Neutral:
   1. On transfer switches requiring fourth pole for switching neutral:
      a. Neutral shall be fully rated with equal withstand, closing and interrupting ratings to power poles.
      b. Switched neutral poles which are add-on or overlap, or that are not capable of breaking full rated load current not acceptable.
   2. Provide neutral disconnect link for 3-pole solid neutral switches, and neutral-to-ground main bonding jumper for switches to meet UL service entrance requirements.

H. Transfer switch shall have multitap voltage selection plug for ease of voltage adjustment in field.

I. Provide transfer switches applied as service entrance switches with overcurrent trip units and service entrance label.

J. Provide external key-operated selector switch to disconnect power supplies.

K. Indicators shall be provided to show availability of each source as well as breakers in a tripped or disconnected position.

L. Provide ground fault protection for switches rated 1.000 amperes or more applied on 480Y/277V ac systems in accordance with NEC Article 230.

2.04 MICROPROCESSOR-BASED CONTROLLER

A. Transfer switch shall be controlled by a UL 1008-listed microprocessor-based controller.

B. Controller shall be hardened against potential problems from transients and surges.

C. Operation of transfer switch and monitoring of both sources shall be managed by controller.

D. Microprocessor-based logic controller shall be door mounted and shall provide operator with overview of transfer switch status, parameters, and diagnostic data.

E. Voltage range: 0-790 volts (50/60 Hz); accuracy, ±2% of nominal input voltage.

F. Frequency range: 40-70 Hz; accuracy, ±0.1 Hz.

G. Control power input range: From 65 volts ac to 160 volts ac rms 50/60 Hz.

H. Provide LED display indicating:
1. Line-to-line voltages for each source and load.
2. Line frequency for each source.
3. Timer countdown for each timer while functioning.
4. Real-time clock.
5. Set points.

I. Individual LEDs shall indicate:
1. Source 1 available.
2. Source 1 connected.
3. Source 2 available.
4. Source 2 connected.
5. Source 1 preferred.
6. Source 2 preferred.
7. Load energized.
8. Automatic mode.
9. Test mode.
10. Program mode.

J. Voltage and frequency features:
1. Monitor voltage of each phase of normal source and alternate source with undervoltage dropout adjustable from 50% to 97% of nominal and pickup adjustable from dropout setting ±2% to 99% of nominal.
2. Monitor voltage of each phase of normal source and alternate source with overvoltage dropout adjustable from 105% to 120% of nominal and pickup adjustable from dropout setting +2% to 103% of nominal.
3. Frequency of normal source and alternate source shall be monitored with underfrequency dropout adjustable from 90% to 97% of nominal and pickup adjustable from dropout setting +1 Hz to 99% of nominal.

4. Frequency of normal source and alternate source shall be monitored with overfrequency dropout adjustable from 100% to 120% of nominal and pickup adjustable from dropout setting +1 Hz to 101% of nominal.

K. Time delay features, provide:
1. To override momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.
2. On transfer to alternate source, adjustable from 0 to 1,800 seconds.
3. On retransfer from alternate source to normal source, adjustable from 0 to 1800 seconds. Time delay shall be bypassed if emergency source fails and normal source is available.
4. After retransfer that allows generator to run unloaded prior to shutdown, adjustable from 0 to 1800 seconds.
5. For neutral position, adjustable from 0 to 120 seconds.
6. For engine failure to start, adjustable from 0 to 6 seconds.
7. Delays shall be field-adjustable from microprocessor-based controller without use of special tools.

L. Features:
1. Password programming protection.
2. Setpoints shall be stored in nonvolatile memory. Use of external battery source to maintain operation during “dead” periods not required.
3. Capable of communication to monitor all set points and operational characteristics.
4. Program/run switch.
5. Pre-transfer signal, range 0-120 seconds.
6. Plant exerciser, selectable: Disabled or 7-day interval, 0-600 minutes load or no load.
7. Retransfer mode: Manual or automatic.
8. Preferred source selection.
9. Test pushbutton mode: Disabled, load or no load.

M. Input/output contacts:
1. 2 SPST contacts for generator start, rated 5-ampere, 250 volts ac.
2. 4 SPST contacts for control functions, rated 10-ampere, 250 volts ac.
3. 3 SPDT contacts for control functions, rated 10-ampere, 250 volts ac.

N. Manufacturer: Cutler-Hammer Type ATC-600, or equal.

2.05 WIRING/TERMINATIONS

A. Terminal blocks shall conform to NEMA ICS 4.

B. Arrange terminal facilities for entrance of external conductors from top or bottom of enclosure.

C. Main transfer switch terminals shall be suitable for termination of conductors.

2.06 POWER SWITCHING DEVICE

A. Insulated case circuit breakers, Cutler-Hammer Type SPB. or equal.

B. Frame ratings: 400, 800, 1200, 1600, 2000, 2500, 3000, 4000 or 5000 (fixed only) amperes.

C. Breakers:
1. Breakers shall be UL-listed for application in their intended enclosures for 100% of their continuous ampere rating.
2. Breakers shall be electrically operated.
3. Provide selective override circuit on breakers having short-time adjustments but without instantaneous adjustments that will allow selectively up to its rms symmetrical short-time rating.
4. Selective override circuit shall allow breaker to ride through a fully offset (asymmetrical) fault equal to its rms symmetrical short-time rating in a system having an X/R ratio of 6.6 with a maximum single-phase peak current of 2.3 times rms symmetrical short-time ranging. No deviations.

5. Provide breakers with true, 2-step stored energy mechanism providing maximum of 5-cycle closing.
6. Energy required for closing breakers shall be completely stored and held in readiness pending release to close action.
7. Insulated case breakers shall have high-endurance characteristics being capable of no-load and full-load interruptions at rated current equal to or exceeding UL endurance ratings for molded case breakers without maintenance.

2.07 CUSTOMER METERING

A. Where indicated, provide separate customer metering compartment with front hinged door and include:
   1. Current transformers wired to shorting-type terminal blocks.
   2. Voltage transformers including primary fuses and secondary DIN rail mounted miniature circuit breakers with alarm contacts and disconnecting means or fused potential taps as potential source for metering.

2.08 ENCLOSURE

A. Provide transfer switch in NEMA 3R ENCLOSURE.

B. NEMA 1, 12 or 3R enclosures: Painted with manufacturer's standard ANSI 61 light gray.

C. NEMA 4 or 4X enclosures: Stainless steel, unpainted.

2.09 PAINTS AND FINISHES

A. Surface preparation and paint shall be in accordance with manufacturer's standard paint specification.

2.10 IDENTIFICATION AND TAGGING

A. Securely attach nameplates with self-tapping stainless steel screws. Adhesive nameplates not acceptable.

B. Lettering: Black on white background.

C. Terminal blocks shall be clearly identified for wiring.

2.11 SOURCE QUALITY CONTROL

A. Perform manufacturer's standard factory tests on assemblies.

B. Perform standard factory tests equipment provided.

C. Tests shall be in accordance with UL and NEMA standards.
   1. Insulation check to verify integrity of insulation and continuity of entire system
   2. Visual inspection to verify switch matches specification requirements and to verify that fit and finish meet quality standards.
   3. Mechanical tests to verify that switch power sections are free of mechanical hindrances.
   4. Electrical tests to verify complete electrical operation of switch and to set up time delays and voltage sensing settings of logic

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations.

DATA SHEETS AUTOMATIC TRANSFER SWITCH		Equipment Name: Tag No.: xxx-###	REV. #
DESCRIPTION	**UNITS / OPTIONS**	**SPEC DATA**	**VENDOR DATA**
Manufacturer	N/A	By Manufacturer	
Catalog/Serial No.	N/A	By Manufacturer	
Environmental Conditions:			
Ambient Temperature Range	°F	100 to -20	
Specific local Building Code and specific relevant sections used in equipment design.	---	By Manufacturer	
Enclosure:			
Location	Indoor/Outdoor	Outdoor	
NEMA Rating	-	4X	
Enclosure Dimensions	LxWxD	By Manufacturer	
Mounting	Wall/free standing	Wall	
Ratings:			
Voltage Class	V	600	
Operating Voltage	V	240	
Continuous Current Rating	A	600	
Phases	1 or 3	1	
Frequency	Hz	60	
Interrupting Current	kA	65	
Closing Current Rating	A		
Withstand Current Rating	A		
Main Bus:			
Material	Copper or Aluminum	Mfgr. Standard	
Fault Current Rating	kA Braced For		
Incoming Supply – Normal And Alternate:			
Cable Entry Point	Top/Bottom	Bottom	
Conductor Type	Material, Insulation, Size		
Phase Conductor Size	-	Per Drawings	
Number of Conductor Sets/Phase	Qty.	Per Drawings	
Ground Conductor Size	-	Per Drawings	
Neutral Conductor Size	-	Per Drawings	
Lug Material	Cu/Al		
Operating Characteristics:			
Open Transition with Adjustable Time Delay	Y/N	Y	
Closed Transition	Y/N	Y	
3-Phase Sensing of Emergency Source	Y/N	Required	
Toggle Switches for Selecting Auto or Manual Transfer and Retransfer	Y/N	Required	
Neutral Transfer	Y/N	N	
Auxiliary Contacts	Y/N	N	
Switch Position	NO/NC Sets	0/0	
Normal Power Available	NO/NC Sets	0/0	
Alternate Power Available	NO/NC Sets	0/0	
Trouble Alarm	NO/NC Sets	0/0	
Selector Switch Manual/Auto	NO/NC Sets	0/0	

DATA SHEETS AUTOMATIC TRANSFER SWITCH		Equipment Name:	
		Tag No.: xxx-###	REV. #
DESCRIPTION	**UNITS / OPTIONS**	**SPEC DATA**	**VENDOR DATA**
Tests and inspections:			
Owner Inspection	Required/Witness	W	
Routine Shop Tests	Required/Witness	W	
Functional Shop Tests	Required/Witness	R	
Accessories:			
Operation and Maintenance Tools	Yes/No	Y	
Enclosure Space Heaters	Yes/No, Voltage	Y	
Thermostat	Yes/No, Voltage	Y	
Indicating Lights	Qty	5; Normal Power Available Alternate Source Available Switch in “Auto” Switch in “Manual” Trouble	
UL Label	Yes/No	Y	
Miscellaneous:			
Nameplate Details	Material, Text Language	English	

END OF SECTION

1) B. A. Wachtel
2) L. E. Ingram