CHAPTER TWO

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PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Provide all labor, equipment, and materials necessary for completing the Maffitt Lake Booster Station Building and Installation Project.

B. The intent of this project is to construct a new booster station building with booster pump equipment to increase water supply to the residences of Polk City and rural areas of Polk County. The project includes site work, construction of a new building to house pumping equipment, installation of pumping equipment and piping, along with required electrical and mechanical work.

C. Work under this Contract includes, but is not necessarily limited to:
   1. Site work including erosion control, dewatering, clearing and grubbing, site grading, site drainage piping, excavating, trenching, water utility piping, paving, and backfilling.
   2. Construction of booster station building including structural fill, footings, below grade walls, and cast-in-place concrete floor. The above-grade wall shall be CMU block with metal siding. Roof to be sloped metal roof.
   3. Procuring and installing booster pumps, valves, piping, and all necessary connections for a complete and operating system.
   4. Installation of new piping to connect booster station to existing distribution pipe, along with required inside piping.
   5. Electrical work and related systems, including new electrical service, power distribution equipment and circuitry, grounding system, indoor and outdoor lighting, along with new motor control center, panelboards, lighting transformers, generator, and control equipment.
   6. Building heating, ventilating, and air conditioning.
   7. Internal plumbing to include building water and drainage.

D. The Board will award a single Contract for the Work included in the Base Bid.

1.02 WORK TO BE PERFORMED BY OWNER

A. Owner will obtain and provide all variable frequency drives identified in the contract drawings and detailed in these Specifications.

1.03 FORM AND INTERPRETATION

A. Detailed Specifications are in outline form and include incomplete sentences; omission of words or phrases is intentional; supply omitted words or phrases by inference.

B. Report errors or ambiguities in Drawings and Specifications to Engineer as soon as detected. Engineer will answer questions regarding Drawings and Specifications and interpret intended meaning of Drawings and Specifications. Engineer's interpretation to be accepted as final.

1.04 DEFINITIONS

A. "Project" means the undertaking described in and governed by the Contract Documents.
1.05 SAFETY AND HEALTH REQUIREMENTS

A. Comply with applicable OSHA regulations and otherwise ensure that the Work is conducted in a safe manner. Without limiting the Contractor’s responsibility, Contractor shall comply with the following:
   1. Iowa Occupational Safety and Health Act of 1972 (IOSHA).
   4. Other applicable federal statutes.

B. Submit health and safety plan specific to this Project that describes safety policies in force and safety procedures to be followed.

C. Complete Safety Performance Questionnaire at the end of this Section and submit with Proposal.

D. Provide for availability of medical services and accessibility of first aid kits. Conspicuously post telephone numbers of doctors, hospitals, and ambulances.

E. Maintain operable fire extinguishers or other fire-fighting equipment on jobsite.

F. Submit Material Safety Data Sheets to Owner prior to commencing the Work for materials used during, or incorporated into, the Work.

G. Provide no less than one temporary toilet facility on each jobsite for use by workers.

1.06 ENERGY MANAGEMENT AND ENERGY PERFORMANCE IMPROVEMENTS

A. Owner evaluates energy performance improvement and operational control in its design of all new and replacement facilities, equipment, systems and processes.

B. Owner will assume that all materials and equipment incorporated into the Contract meets or exceeds energy efficiency requirements.

C. All changes or modifications to the Contract during construction must be evaluated and approved by the Engineer to ensure that the change does not negatively affect the energy performance of the facility.

1.07 RIGHT-OF-WAY AND LAND ACQUIRED FOR THE WORK

A. Owner will provide to Contractor, at no cost, the easements shown on Plans for performance of Work.

B. Obtain the following from Owner prior to beginning construction:
   1. List of easements or right-of-way not acquired.
   2. Special instructions pertaining to properties affected by Work.

1.08 CONTRACT COMPLETION TIMES

A. Notice to Proceed will be issued as soon as practical after Contract is signed and the Contract, Contractor’s Bond, and insurance certifications required by the Contract are received by the Board.

B. The work under this Contract will be substantially completed by the date set forth in the Notice to Proceed.

C. The Project will be considered substantially complete after the Owner has decided that installation, testing, and training of all equipment and appurtenances is complete. Substantial completion shall include submission of all start-up reports and agreement by Engineer that facility can be fully used by the Owner.
D. Final completion shall include all remaining items including, but not limited to, restoring the site to an equal or better condition, disposal of used, salvaged, or usable materials, final grading and seeding, and completion of all items addressed in the final project closeout punch list. Final completion shall also include submittal of all closeout documents including record drawings.

E. Comply with provisions of Paragraph 1.8-6 of Chapter 1, General Provisions and Covenants, for requests to extend Contract Time.

1.09 LIQUIDATED DAMAGES

A. Contractor and Owner recognize that time is of the essence and that Owner will suffer financial loss if the Work is not completed within the times specified, plus extensions thereof allowed in accordance with Chapter 1. The parties also recognize the delays, expense, and difficulties involved in providing a legal or arbitration proceeding regarding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay Owner according to the following:
   1. Liquidated damages, in the amount of Five Hundred Dollars ($500) per consecutive calendar day, will be assessed for each calendar day the improvements remain incomplete after the specified completion time.

B. Complete improvements under this Bid by date set forth in the Notice to Proceed.

1.10 CONSTRUCTION PROGRESS SCHEDULE

A. Submit an anticipated schedule of proposed construction activities within 5 days of receipt of Notice of Award.

B. Begin work as directed by the Notice to Proceed.

C. Review and provide construction schedule at the Preconstruction Conference in written and graph form. The schedule shall define all construction activities, including target beginning and completion dates for various facilities, indicate milestones and all critical path events and have notations of how many crews and subcontractors will be used and when they will start and end.

1.11 MEASUREMENT, PAYMENT, AND ACCEPTANCE.

A. Owner will make monthly partial payments based on work and labor performed and materials furnished as specified under Section 1.9-4 of General Provisions and Covenants.
   1. Contractor will propose a schedule of values for lump sum projects. Schedule of values will be submitted for review and approval by Engineer.
   2. Items not listed as specific bid items will not be measured and will be considered as incidental items. Pay for incidental items shall be included in unit bid payments.

B. Owner will accept Work and make final payment to Contractor when:
   1. Engineer has certified that improvements constructed by Contractor are satisfactory and conform to Drawings and Specifications.
   2. Contractor has filed with Owner all documents called for in Specifications.
   3. Owner may require Contractor to submit:
      a. Documentation that no sales or use tax was paid for building materials, supplies, or equipment used in the performance of the Contract.
      b. Iowa Department of Revenue Form 35-002a from Contractor and each subcontractor to whom a portion of the Contract has been sublet, assigned, or otherwise disposed if sales or use tax has been paid.

C. Acceptance and final payment will be as specified under Section 1.9-6 of General Provisions and Covenants.
1.12 PRE-BID AND PRECONSTRUCTION CONFERENCE

A. Attend a Pre-Bid Conference and tour of Project Site as part of the bidding process.
   1. Pre-Bid Conference will be held at 1:00 p.m. on June 2, 2020 electronically over Zoom. Notices of how to attend will be sent out prior to the meeting. A site visit will take place following the electronic meeting.
   2. All contractors intending to bid this Project are encouraged to attend.

B. Attend Preconstruction Conference at a time mutually acceptable to Owner and Contractor. The Contractor’s representatives shall include project superintendent.

C. Submit following information at, or prior to, Preconstruction Conference:
   1. List of suppliers and subcontractors for review by Owner.
   2. Schedule for completing the Work.
   3. Phone numbers of Contractor’s project personnel to contact during working and non-working hours.

D. Attend periodic coordination meetings, as needed, to coordinate Work with Owner’s operations.

1.13 INSPECTION BY OWNER

A. Assign an inspector, or agent of the Owner, to the Project to perform duties specified in Section 1.5-2 of Chapter 1.

B. Owner recognizes the following as legal holidays in 2020:
   1. Memorial Day May 25, 2020
   2. Independence Day July 3, 2020
   3. Labor Day September 7, 2020
   4. Thanksgiving November 26 and 27, 2020
   5. Christmas December 24 and 25, 2020

1.14 SURVEYS

A. Owner will provide benchmark elevation at North American Vertical Datum of 1988 (NAVD88) for Contractor’s use.

B. Contractor to provide and coordinate all surveys necessary to:
   1. Obtain necessary data and measurements for fabrication and ordering of materials.
   2. Complete all work with alignment and grades shown on drawings.
   3. Produce or confirm accurate as-built information for Owner.

1.15 SUBSTITUTE AND “OR-EQUAL” ITEMS APPROVAL

A. Engineer will review and approve substitute and “or-equal” items prior to bidding. Manufacturers and suppliers of equipment and products wishing to obtain approval as a substitute or “or-equal” item for use within this Project must submit the required information for consideration by Engineer, a minimum of 7 days prior to bid opening. Substitute and “or-equal” equipment and products that meet substantial compliance with the specifications, based upon Engineer’s judgement, will be listed within an Addendum prior to Bid.

B. Submit the following information for consideration as a substitute and “or-equal” item:
   1. Specific Product Literature or cut sheets identifying the product in question.
   2. Line-by-line exemptions to specific specifications applicable to the product in question.
1.16 SHOP DRAWINGS

A. Submit Shop Drawings to Owner in Standard PDF (.pdf) format. Use of scanned images is discouraged as submittals without suitable contrast and clarity will be rejected on the basis of form.

B. Submit the following:
   1. Requested information specified in other sections of Specifications.
   2. Information requested by Engineer.
   3. An electronic copy of a transmittal cover sheet with each Shop Drawing submittal.

C. Contractor’s responsibility prior to submission of Shop Drawings to Engineer:
   1. Check Drawings for coordination and conformance with Contract; do not submit without checking.
   2. Affix Contractor’s stamp with signature of responsible person to show that data being submitted has been checked and approved by Contractor; Shop Drawings submitted without appropriate stamp and signature will be returned without action by Engineer.

D. Intent of Engineer’s review of Shop Drawings: to assist Contractor in interpretation of Specifications.

E. Engineer’s review is only to verify general conformance with design concept and general compliance with information given in Specifications.
   1. Any action shown is subject to requirements of Specifications.
   2. Contractor is responsible for dimensions, fabrication processes, manufacturing techniques, means of construction, and satisfactory performance of Work.

F. Approximate Shop Drawing review time required by Engineer: 15 calendar days from date of receipt.

G. Do not incorporate materials into the Work until pertinent Shop Drawings have been reviewed and marked by Engineer.

1.17 WARRANTY AND MAINTENANCE

A. In addition to warranties implied by law, the Contractor expressly warrants work performed under this Contract to be free from defects in materials and workmanship for a period of 2 years from and after completion and acceptance by the Board of Water Works Trustees. Should defects be discovered during this period, the Contractor will repair the defect at its sole cost and expense upon notice from the Owner.

B. Submit written report stating intentions and schedule for completing repairs within 7 days after being notified of need for repairs.

C. If Contractor fails to make needed repairs, Owner shall have the right to make repairs and collect cost of doing the repairs from Contractor or his bondsman.

D. Provide Maintenance Bond to cover provisions of this Section.

E. Following notice of Warranty item, Contractor has 7 calendar days to begin work on addressing Warranty item. If Contractor does not address Warranty item within 7 calendar days, Owner reserves the right to make required repairs which will then be billed to the Contractor.

1.18 COORDINATION

A. Coordinate and cooperate with Des Moines Water Works’ staff who may be working in the Project area.

B. During construction of this Project, the Contractor will be required to coordinate his operations with those other contractors working within the same area.

C. Coordinate with the appropriate agencies the relocation of utilities required to complete the Work.
1.19 TEMPORARY UTILITY SERVICE

A. Contractor to coordinate and pay for temporary electrical service during construction. Provide all facilities necessary for temporary electrical service.

B. Temporary water service is not available near the Project site until contractor installs facilities for temporary water.

C. Once facilities are available, water needed to complete the Work will be provided by the Owner at no cost to the Contractor.

D. Provide necessary hoses, piping, and all fittings necessary to deliver water from the water meter to the point of use.

E. Prevent freezing/damage to Owner-provided equipment.

1.20 PERMITS

A. Owner has applied for or will apply for, but not received, the following permits:
   1. Iowa DNR Water Supply Construction Permit and Schedules.

B. Contractor shall be responsible for obtaining all other regulatory permits associated with the Work.
   1. Polk County Grading Permit.
   2. Polk County Traffic Control Permit.
   4. Plumbing permit.
   5. Mechanical permit.
   6. Electrical permit.
   7. Right of way use permit.
   8. Other required permits.

C. Later permit approval affecting Contract schedule will justify Contract period extension. Late Permit approval does not entitle the Contractor to an increase in Contract Price.

1.21 QUALITY ASSURANCE AND QUALITY CONTROL

A. Work to be performed only by personnel experience in type of construction being performed.

B. Comply with codes, ordinances, rules and regulations, orders, and other legal requirements of public authorities, which bear on the performance of the Work.

C. Give required notices as defined by the Contract Documents. Exceptions to this are not allowed.

D. Promptly submit written notice to Engineer of observed variance of the Contract Documents from legal requirements. Assume responsibility for work known to be contrary to such requirements, without notice.

E. Enforce strict discipline and good conduct and order among employees. Do not employ on the Work:
   1. Unfit persons.
   2. Persons not skilled in assigned tasks.
1.22 ADDITIONAL INFORMATION

A. Access is available to site for additional pre-bid tests and investigations on the following basis:
   1. Submit outline of test procedures to Owner for review before conducting any tests or investigations at the site.
   2. Notify Owner a minimum of 24 hours before needing access to site.

** END OF SECTION **
SECTION 01 57 00
SLOPE PROTECTION AND EROSION CONTROL

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Implementation of construction practices to minimize soil erosion and control water pollution.

B. Prevention of eroded soil from leaving construction site and entering onto adjacent property or into waterways.

C. Installation and maintenance of slope protection, slope stabilization, erosion control devices, and stabilized construction entrance.

D. Removal of temporary erosion control devices used during construction.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 31 11 00 – Clearing and Grubbing.

C. Section 31 22 00 – Site Grading.

D. Section 32 92 19 – Seeding.

E. Section 32 13 10 – Sidewalk, Driveways, and Temporary Access.

F. Section 33 14 11 – Ductile Iron and Polyvinyl Chloride Pipe for Buried Piping.

1.03 REFERENCES

A. Iowa Department of Transportation (IDOT) Standard Specifications for Highway and Bridge Construction – current year, including Supplemental Specification.

B. Iowa Statewide Urban Design and Specifications (SUDAS).

1.04 SUBMITTALS

A. Submit erosion control work plan to Owner a minimum of 2 weeks prior to beginning construction. Include the following information:
   1. Materials, methods, and equipment to be used.
   2. Location of silt fences and other temporary erosion control measures.
   3. Schedule for installation of erosion control and pollution control measures as construction progresses.

B. Submit catalog data on items to prove complete compliance with specifications.

C. Submit a 6-inch by 6-inch sample of silt fence fabric.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2 PRODUCTS

2.01 SILT FENCE

A. Fabric:
   1. Comply with IDOT Standard Specifications Section 4196.01.
   2. Approved manufacturers:
      a. SCF 1500 I by Fab Tex Solutions, Inc.
      b. Geo Tex 2132 (cord) by Propex Inc.
      c. Style 1215 by Willacoochee Industrial Fabrics, Inc.

B. Posts: Steel with T-section.
   1. Minimum length: 4 feet.
   2. Minimum weight: 1.25 pounds per foot, exclusive of anchor plate.
   3. Fastener: wire or plastic with minimum tensile strength of 50 pounds.

2.02 FILTER SOCK

A. For slope and sediment control applications, use a continuous, tubular, knitted, mesh netting with 3/8-inch openings, constructed of 5 mil thickness, photodegradable HDPE.

B. For inlet protection, use a continuous, tubular, knitted, mesh netting with 3/8-inch openings, constructed of 500 denier polypropylene.

C. Use 1-inch by 2-inch minimum hardwood stakes or stakes of equivalent strength.

PART 3 EXECUTION

3.01 GENERAL

A. In addition to the following provisions, comply with Section 9040, Iowa Statewide Urban Design and Specifications (SUDAS).

B. Coordinate installation of slope protection and erosion control devices with clearing and grading activities.

C. Contractor may use slope protection and erosion control devices that remain at site from work under previous contracts.

D. Regulatory Requirements: Conform to applicable codes, requirements, and statutes for environmental requirements for erosion control.

3.02 EXAMINATION

A. Ensure that soil erosion is minimized; prevent eroded soil from leaving construction areas and entering adjacent property or waterways.

B. Engineer has authority to limit surface area of erodible material exposed by clearing and grubbing, excavation, and backfill operations.

C. Provide immediate, permanent or temporary, erosion control and pollution control measures as clearing, backfill, and grading activities are completed.
3.03 CONTROLS

A. Install silt fence along perimeter of work area on downslope sides of site prior to site clearing and grading operations.

B. Preserve existing vegetation in areas not needed for construction.

C. Provide additional siltation fence, temporary silt basins, diversion dikes, earth dikes, and straw bales around storm sewer inlets and outlets.

D. Provide permanent seeding of areas upon completion of grading as soon as practical.

E. Stabilize disturbed areas where construction activity has ceased but has not been completed.

3.04 FILTER SOCKS INSTALLATION

A. Fill mesh sock with filler material to size and length specified.

B. Install filter sock along contours as shown on Contract Drawings or as directed by Engineer.

C. Turn ends of filter sock so they run uphill, as necessary to prevent runoff from ends.

D. Install filter sock with stakes at a maximum of 10 feet or as required to secure sock and prevent movement.

3.05 SILT FENCE INSTALLATION

A. Install silt fence at locations shown on Plans, at base of stockpiles of excavated material, and other locations as required or directed by Engineer.

B. Place fabric to cover graded slope from normal high waterline to toe of slope.

C. Place fabric on graded slope, with each section overlapping the previous section by approximately 2 feet.

D. Smooth rough areas and wrinkles in fabric.

E. Attach fabric to graded slope by driving staples through fabric and into slope. Place staples as recommended by fabric manufacturer.

F. Reattach loose staples.

G. Install additional staples, as necessary, for secure attachment of fabric to slope.

H. Allow Owner the opportunity to inspect slope after attachment of fabric.
3.06 MAINTENANCE AND REPLACEMENT

A. Maintain temporary and permanent erosion control measures in appropriate functional condition.

B. Clean, repair, or replace non-functioning control devices as needed:
   1. Filter Socks:
      a. Repair or replace non-functioning filter socks that allow water to run under the socks, when socks are torn, or when otherwise damaged.
      b. When accumulated sediment level reaches one-half the height of the sock or as directed by Engineer.
      c. Remove filter material from damaged socks.
   2. Silt fences:
      a. When accumulated sediment reaches a level of one-half the height of the silt fence:
         (1) Remove eroded soil retained by erosion control devices; distribute over eroded areas.
         (2) Replace as specified above.
   3. Stabilized construction entrance: Remove accumulated sediment and install new stone as needed to prevent soil from leaving site on tires of equipment and vehicles.

C. Owner to inspect site every 7 calendar days.

D. Owner will prepare reports summarizing inspections and retain as part of storm water pollution prevention control plan.

3.07 CLEANUP, RESTORATION, AND REMOVAL

A. Remove eroded soil retained by erosion control devices; distribute over eroded areas.

B. Completely remove all temporary erosion control devices from site once areas disturbed by construction under this Contract and previous contracts have been restored and stabilized.

C. Provide seeding for areas disturbed by construction.

** END OF SECTION **
SECTION 01 73 19

EQUIPMENT INSTALLATION

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Installation and erection of equipment specified.

B. Installation and erection of equipment provided by Owner.

C. Receiving, transporting, unloading, and storing of all equipment, including equipment provided by Owner.

D. Foundations for all equipment, including but not limited to equipment pads, generators, and electric transformer(s).

E. Anchor bolts, fasteners, and sleeves for all equipment.

F. Specific requirements for equipment installation are included with manufacturer's drawings and instructions.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 03 20 00 – Concrete Reinforcement.

C. Section 03 30 00 – Cast-in-Place Concrete.

D. Section 05 50 00 – Metal Fabrication.

E. Section 07 92 00 – Joint Sealers.

F. Section 08 11 00 – Steel Doors and Frames.

G. Section 08 71 00 – Door Hardware.

H. Division 23 – Heating, Ventilating, and Air Conditioning.

I. Division 26 – Electrical.

J. Section 40 05 56 – Process Valves and Specialties.

K. Section 40 23 23 – Inside Process Piping and Appurtenances.

1.03 REFERENCES (NOT USED)

1.04 SUBMITTALS (NOT USED)

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2  PRODUCTS

Included as part of Part 3 Execution.

PART 3  EXECUTION

3.01  RECEIVING, TRANSPORTING, AND STORING

A. Receive all shipments of equipment at job site or local freight terminal.

B. Inspect all material and equipment as it is received from the carrier, including Owner-provided equipment received at jobsite. Notify Owner immediately of any damage to Owner-provided equipment.

C. Transport, as required, and unload at jobsite.

D. Contractor is responsible for all aspects of rigging, unloading, handling, storing, and protecting of all equipment incorporated into project.
   1. Lift only by means that comply with manufacturer’s instructions.
   2. Provide additional slings, if necessary, to prevent tipping or rotation.
   3. Use spreaders with slings attached to the lifting lugs to prevent damage while lifting equipment.
   4. Coordinate off-loading of booster station equipment with manufacturer and Owner. Contractor to pay any additional fees due to delays in unloading.

E. Store equipment in manner and location that will ensure complete fitness for operation.
   1. Protect from rust, corrosion, weathering, vibration, and vandalism.
   2. For short-term storage (less than one day) of pump and motor:
      a. Storage area surface must be level, stable, and not subject to flooding.
      b. Support equipment on blocks at intervals along pump column to keep weight off of flanges and the suction bell.
      c. Coat all machined surfaces and exposed shafting with rust preventative.
   3. Leave piping connection covers in place to keep dirt and other foreign material out of pump.

F. Follow all other manufacturer’s requirements and recommendations for handling, storing, and protecting equipment.

G. Pay all demurrage or storage charges for Contractor-supplied equipment.

3.02  ASSEMBLY AND ERECTION

A. Completely assemble all equipment shipped knocked down; furnish minor items such as nuts, bolts, washers, pins, and pipe fittings necessary for assembly and operation; use materials compatible with equipment.

B. Erect and install, ready for operation.

C. Furnish stainless steel anchor bolts and fasteners not supplied with equipment.

D. Provide additional concrete and grout required for pump and other bases.
3.03 SUPPORTS AND FOUNDATIONS

A. Provide devices for supporting all equipment in accordance with recommendations of manufacturer and as shown on Plans or reviewed Shop Drawings.
   1. Concrete pads for floor-mounted equipment.
   2. Fabricated supports of steel sections, plates, or rods for all hung equipment and bearing supports.

B. Prevent transmission of excessive forces to building structures or pieces of equipment or piping.

C. Align and level equipment; use stainless steel shims as needed.

D. Grout under all equipment on concrete foundations with non-shrink cement grout.

E. Contractor to supply stainless steel anchor bolts, nuts and washers, and templates, unless specified otherwise.

3.04 PROTECTION

A. Structures:
   1. Use cribbing, shoring, or planking to protect structures from moving-in damage.
   2. Repair damage to structures or equipment after equipment is in place.

B. Equipment:
   1. Protect against falling objects that might damage equipment installed before structure is completed.
   2. Protect motors and electrical equipment from moisture and water during delivery and storage.

3.05 CLEANING

A. Clean equipment of all temporary protective coatings.

B. Remove oil, grease, and dirt from external surfaces.

3.06 LUBRICATION

A. Contractor will be responsible to lubricate moving equipment in accordance with manufacturer’s recommendations.

B. Owner will provide lubricants.

3.07 ADJUSTMENTS

A. Make adjustments to equipment necessary to improve operation.

B. Check equipment clearances and adjust in accordance with recommendations of manufacturers.

3.08 INITIAL OPERATION

A. Inspect final installation and supervise initial operation of all equipment.

** END OF SECTION **
SECTION 03 10 00
CONCRETE FORMS AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Formwork for cast-in-place concrete.

B. Design of forms, shores, reshores, and anchorages.

C. Openings for other work.

D. Form accessories.

E. Concrete placement limits.

F. Form stripping.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 03 20 00 – Concrete Reinforcement.

C. Section 03 30 00 – Cast-in-Place Concrete.

D. Section 03 39 00 – Concrete Curing.

1.03 REFERENCES

A. American Concrete Institute (ACI) 117 – Specifications for Tolerances for Concrete Construction and Materials; current version.

B. American Concrete Institute (ACI) 301 – Specifications for Structural Concrete for Buildings; current version.

C. American Concrete Institute (ACI) 318 – Building Code Requirements for Reinforced Concrete and Commentary; current version.

D. American Concrete Institute (ACI) 347 – Guide to Formwork for Concrete; current version.

E. American Hardboard Association (AHA) A135.4 – Basic Hardboard.


G. PS 1 – Construction and Industrial Plywood; National Institute of Standards and Technology (Department of Commerce); current version.

1.04 SUBMITTALS (NOT USED)

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Construct rigid and substantial forms to produce required dimensions and finish of the concrete, and to support wet concrete load, other dead loads, and construction loads adequately.

B. Use smooth metal or approved wood forms on exposed concrete surfaces.

C. Wood Forms:
   1. Plywood/Oriented Strand Board: APA rated sheathing, Exposure 1.
      a. Exposed surfaces: Grade A face veneer - do not use Oriented Strand Board for forms.
      b. Concealed surfaces: Grade B face veneer – Oriented Strand Board forming is acceptable.
   3. Lumber: Suitable species for forming application.
   4. Fasteners: Suitable to maintain formwork during concrete placement.

D. Prefabricated Forms:
   1. Preformed steel forms: minimum 16-gauge matched, tight-fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
   2. PS1, B-B High-Density Overlay Plywood, Class 1: free of deleterious materials and free of damage disfiguring to concrete surfaces.

2.02 FORMWORK ACCESSORIES

A. Equip all forms with adequate devices for spreading and tying formwork and for supporting the steel reinforcement.

B. Form Ties: removable type, galvanized metal, fixed length, cone type with waterstop washer. Form ties shall not leave holes in concrete larger than 7/8-inch diameter. Use commercially manufactured ties. Wire ties or band iron will not be accepted.

C. Form Release Agent: colorless, non-corrosive mineral oil that will not stain concrete or commercially produced release agent.

D. Corners: Chamfered, wood or plastic strip type; 3/4-inch by 3/4-inch size; maximum possible lengths. Plane smooth surface contacting concrete.

PART 3 EXECUTION

3.01 GENERAL

A. Design Requirements
   1. Design, engineer, and construct formwork; shoring and bracing to:
      a. Conform to design and code requirements.
      b. Sustain forces exerted by plastic concrete without shifting or deformation of formwork.
   2. Resultant concrete to conform to required shape, line, and dimension.
   3. Tolerances: Conform to ACI 117.
      a. Deviations from horizontal and vertical lines:
         (1) 1/4 inch in 10 feet.
         (2) 3/8 inch in 20 feet.
         (3) 3/4 inch in 40 feet or more.
      b. Deviation from indicated positions shown on Plans: 1/4 inch from true position.
   4. Design and engineering of formwork shall be the responsibility of the Contractor.

B. Obtain approval from Engineer for any opening formed in structural members.
C. Quality Assurance
   1. Perform Work of this Section in accordance with ACI 117, ACI 301, ACI 318, and ACI 347.

D. Delivery, Storage, and Protection
   1. Deliver form materials to project site in an undamaged condition.
   2. Store and protect form materials in a manner that prevents damage or deterioration.

3.02 EXAMINATION

A. Verify lines, levels, and centers before proceeding with formwork. Ensure that dimensions agree with Plans.

3.03 EARTH FORMS

A. Hand trim sides and bottom of earth forms.
   1. Vertical configuration: true, vertically plumb, and cleanly cut.
   2. Horizontal configuration: true, level, or uniformly sloping.

B. Remove loose soil, organic materials, man-made materials, debris, or other deleterious materials prior to placing concrete.

C. Remove depressions or protrusions that alter member dimensions by more than 5 percent.

D. In cases where soil has been disrupted or excavated beyond a 5 percent variance in dimension, the footing sides shall be formed to maintain a uniform cross-section.

3.04 FREE FORMING

A. Obtain approval of Engineer prior to placement of free-formed concrete.

B. Free form only with concrete stiff enough to maintain shaped profile, true lines and uniform surfaces.

C. Provide backup support for all free-formed surfaces.

3.05 ERECTION – FORMWORK

A. Erect formwork, shoring, and bracing to achieve design requirements, in accordance with requirements of ACI 301 and ACI 347.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight. Keep form joints to a minimum.

E. Provide chamfer strips on exterior corners where indicated in Contract Documents.

F. Coordinate this Section with other Sections of work that require attachment of components to formwork.

G. Maintain concrete cover regardless of sequence of reinforcing steel erection.
3.06 APPLICATION – FORM RELEASE AGENT
A. Clean forms thoroughly before applying release agent.
B. Apply form release agent on formwork in accordance with manufacturer’s recommendations.
C. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
D. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.
E. Do not allow form release agent to puddle in forms or come into contact with existing concrete or reinforcing steel.

3.07 INSERTS, EMBEDDED PARTS, AND OPENINGS
A. Provide formed openings where required for items to be embedded in or passing through concrete work.
B. Locate and secure in place items that will be cast directly into concrete.
C. Coordinate with work of other Sections in forming and placing openings, slots, reglets, recesses, pipe sleeves, conduit sleeves, bolts, anchors, other inserts, and components of other work.
D. Install accessories in accordance with manufacturer’s instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.

3.08 FORM CLEANING
A. Clean forms as erection proceeds, to remove foreign matter within forms.
B. Clean formed cavities of debris prior to placing concrete.
C. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.09 FIELD QUALITY CONTROL
A. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.
B. Do not reuse custom wood formwork more than three times for concrete surfaces to be exposed to view. Do not patch formwork.

3.10 FORM REMOVAL
A. Removal time of forms to be determined by the following requirement:
   1. Cumulative days elapsed beyond concrete placement.
B. Forms to be removed no sooner than:
   1. Ambient air temperatures above 50 degrees.
      a. Slab edges (1-foot-thick or less) – 1 day.
      b. Vertical Elements including walls and pipe supports 3 days.
   2. Ambient air temperatures below 50 degrees.
      a. Structural elements – 14 days.
      b. Non-structural elements – 3 days.
C. In no case shall external loads, including wall backfilling, be applied to any structural member until concrete has achieved 100 percent of specified compressive strength according to ASTM C39.

D. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

E. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

**END OF SECTION**
PART 1  GENERAL

1.01  SUMMARY OF WORK
A. Reinforcing steel for cast-in-place concrete.
B. Supports and accessories for steel reinforcement.

1.02  RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 03 30 00 – Cast-in-Place Concrete.
C. Section 03 39 00 – Concrete Curing.

1.03  REFERENCES
B. American Concrete Institute (ACI) 301 – Specifications for Structural Concrete for Buildings; current version.
C. American Concrete Institute (ACI) 315 – Details and Detailing of Concrete Reinforcement; current version.
D. American Concrete Institute (ACI) 318 – Building Code Requirements for Reinforced Concrete and Commentary; current version.
1.04 SUBMITTALS

A. Placing Drawings: Comply with the requirements of ACI 315 and CRSI DA4.
   1. Include bar schedules, bent bars shapes, spacing of bars, locations of splices and proper staggering of splices.
   2. Provide sufficient detail to permit installation of reinforcing without reference to the Contract Drawings.

B. Shop Drawings:
   1. Do not prepare by reproducing the Plans and details provided on the Contract Drawings.
   2. Redraw plans, wall elevations and details as necessary to indicate complete fabrication and installation of all reinforcing steel.
   3. Show required concrete clear cover on all section views for each face of concrete.

C. Product Data:
   1. Manufacturer and type of proprietary rebar mechanical or welded splices and manufacturer's test results.
   2. Manufacturer and type of adhesive rebar anchor including installation instructions, pullout test results and depth of embedment required to attain pullout strength of 125 percent of yield strength.
   3. Certify that reinforcing steel and accessories supplied for this Project meet or exceed specified requirements.
   4. Submit certified copies of mill test report of reinforcement materials analysis upon request.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Bars: ASTM A615, Grade 60 (420).
   1. Deformed billet-steel bars, unfinished.
   3. Weldable Reinforcing: ASTM A706, Grade 60.

B. Reinforcement Accessories: Conform to ACI 315 and CRSI DA4.
   1. Tie Wire: Annealed, minimum 16-gauge, vinyl coated in exposed surface faces.
      a. For chairs, bolsters, bar supports, and spacers sitting on vapor barrier on grade, load bearing pads on bottom are required to prevent vapor barrier puncture.
      b. Maximum spacing of chairs/bar supports/spacers:
         (1) Flatwork: 4 feet on center in each direction.
         (2) Walls: 6 feet on center in each direction.
         (3) Provide stainless steel or plastic components for placement within 1-1/2 inches of weathering surfaces or surfaces that will be exposed to process water.
   3. Epoxy Adhesive (for anchoring dowels):
2.02 FABRICATION


B. Welding of reinforcement is permitted only with specific approval of Engineer. Perform welding in accordance with AWS D1.4 using only ASTM A706 bars in welded applications.

C. Shop-fabricate all bent reinforcing bars using proper cold-bending forming techniques in accordance with ACI 315.

D. Fabrication Tolerances:
   1. Sheared lengths: plus or minus 1 inch.
   2. Overall dimensions of stirrups, ties and spirals: plus or minus 1/2 inch.
   3. All other bends: plus 0 inches, minus 1/2 inch.

E. Identification:
   1. Ship rebar to jobsite with attached plastic or metal tags.
   2. Place on each tag the mark number of the rebar corresponding to the mark number indicated on the Shop Drawing.
   3. Mark numbers on tags to be so placed that the numbers cannot be removed.

F. Locate reinforcing splices not indicated on Drawings at point of minimum stress. Review locations of splices with Engineer.

PART 3 EXECUTION

3.01 GENERAL

A. Refer to Plans for additional reinforcement requirements for structural elements and slab-on-grade concrete.

B. Quality Assurance
   1. Verify that reinforcing steel meets applicable specifications.
   2. Perform Work of this Section in accordance with ACI 301.
   3. Reinforcing Steel Fabricator: Company specializing in performing the Work of this Section with minimum of 5 years of experience. Submit documentation of experience upon request.

C. Delivery, Storage, and Handling
   1. Deliver reinforcing to site in an undamaged condition and free of rust, grease, dirt, and debris or other deleterious or foreign materials.
   2. Store in a manner to protect from rusting and contact with injurious materials. Elevate above ground. Clear rust from rusted reinforcing prior to placement of concrete.

3.02 PLACEMENT

A. Place reinforcing steel in accordance with ACI 315 and CRSI DA4.

B. Place, support, and secure reinforcement against displacement not deviating from required position.
   1. Use preformed wire bar bolsters and spacers on concrete casting above grade.
   2. Use concrete brick or similar cast concrete components to support reinforcing in footings.

C. Place concrete only after reinforcing system is in place and approved by Engineer.
   1. Install reinforcing system plumb and true.
   2. Tie reinforcing system securely.
3. Maintain system in proper position without distortion or displacement of individual bars or system during pour.

4. Minimum concrete cover required for reinforcing system:
   a. Concrete cast against permanently exposed earth: 3 inches.
   b. Concrete formed and permanently exposed to earth or weather: 2 inches.
   c. Concrete cast or formed under other conditions: 1-1/2 inches.

D. Accommodate placement of formed openings. Provide additional reinforcement at openings as required by Contract Drawings.

E. Splices:
   1. Make all joints and splices using approved mechanical splices or by lapping the ends of the bars according to lap lengths scheduled or shown on Plans.
   2. Splicing top bars over supports and bottom bars at center span is not permitted.
   3. Staggering of splices (use the following minimums, unless a greater stagger is specifically noted on Plans):
      a. Lap splices in longitudinal bars: minimum of one full lap length.
      b. Mechanical splices: minimum of 12 inches.

F. Field bending of reinforcing bars is not permitted.

G. Adhesive Rebar Anchors:
   1. Install anchors using only materials, equipment, and procedures recommended by manufacturer. Follow all manufacturer’s installation and curing instructions.
   2. Use anchors only at locations specifically indicated on Contract Drawings or approved by Engineer.
   3. Install adhesive-anchored dowels when used as indicated on Contract Drawings.

H. Epoxy Adhesive Dowels:
   1. Drill hole 1/8 inch larger than nominal bar diameter and to a depth 1/2 inch greater than design embedment.
   2. Clean hole completely with brush and air blast removing debris and loose material.
   3. Fill hole 1/2 full with properly mixed epoxy adhesive.
   4. Insert dowel while rotating two full turns, or two 180-degree sweeps for L-shaped bars, distributing epoxy over full annular space.
   5. Agitate dowel to remove all air voids and drive dowel to full depth embedment.

3.03 FIELD QUALITY CONTROL

A. Inspect all reinforcement for compliance with Contract Documents. If deficiencies are not corrected, or if an interpretation of the Contract Documents is required, notify Engineer immediately.

** END OF SECTION **
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Cast-in-place concrete.
B. Concrete mixes, proportioning, and testing.
C. Grout for embedment items.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.
B. Section 03 10 00 – Concrete Forms and Accessories.
C. Section 03 20 00 – Concrete Reinforcement.
D. Section 03 39 00 – Concrete Curing.
E. Section 07 92 00 – Joint Sealants.

1.03  REFERENCES

A. American Concrete Institute (ACI) 117 – Standard Specifications for Tolerances for Concrete Construction and Materials; current version.
B. American Concrete Institute (ACI) 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Re-approved 1997).
C. American Concrete Institute (ACI) 301 – Specifications for Structural Concrete for Buildings; current version.
D. American Concrete Institute (ACI) 302.1R – Guide for Concrete Floor and Slab Construction; current version.
E. American Concrete Institute (ACI) 304R – Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
F. American Concrete Institute (ACI) 305R – Hot Weather Concreting; current version.
G. American Concrete Institute (ACI) 306R – Cold Weather Concreting; current version.
H. American Concrete Institute (ACI) 308 – Specification for Curing Concrete.
I. American Concrete Institute (ACI) 318 – Building Code Requirements for Reinforced Concrete and Commentary; current version.
L. American Society for Testing and Materials (ASTM) C138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.


BB. Iowa Department of Transportation (Iowa DOT) Standard Specifications for Highway and Bridge Construction, current version.

CC. Iowa Department of Transportation (Iowa DOT) Materials I.M. 401 – Hydraulic Cements.
DD. Iowa Department of Transportation (Iowa DOT) Materials I.M. 409 – Source Approval for Aggregates.

EE. Iowa Department of Transportation (Iowa DOT) Materials I.M. 529 – Portland Cement (PC) Concrete Proportions.

1.04 SUBMITTALS

A. Product Data:
   1. Provide certification that sources of Portland cement, fly ash, and aggregates meet or exceed specified requirements.
   2. Submit manufacturers' data on admixtures and manufactured products.

B. Concrete Mix Design:
   1. For each type of concrete used, submit mix design indicating the following (all as required for one cubic yard of concrete):
      a. Dry weights of cement, fly ash, and other cementitious materials when applicable.
      b. Saturated surface dry weights of course and fine aggregates.
      c. Type and dosage of admixtures when applicable.
      d. Total gallons of water – including aggregate moisture.
      e. Source and gradation of both course and fine aggregates.
   2. Contractor to submit mix design and supporting data for review at least 14 calendar days prior to its use.

C. Concrete Mix Design – Supporting Data:
   1. For each type of concrete to be used, submit appropriate field experience or trial mixture data.

D. Concrete delivery tickets showing concrete delivered to site complies with approved mix design.
   Delivery tickets shall meet IDOT standards and shall include the following information:
   1. Contractor.
   2. Concrete supplier.
   3. Date and time of delivery to site.
   4. Breakdown of mix or mix design number.
   5. Quantity and time batched.
   6. Moisture content of coarse and fine aggregates.
   7. Quantity of water that can be added at the site and not exceed the maximum specified water/cement ratio.

E. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement: ASTM C150, Type I or Type I/II – Normal, unless noted otherwise on Plans, Portland type less than 1 year of age. Tricalcium aluminate not to exceed 8 percent.

B. Coarse Aggregates: Meeting ASTM C33 & IDOT 4115.
   1. Clean, hard, durable, uniformly graded mineral aggregate particles free from injurious amounts of silt, shale, coal, organic matter, or other deleterious substances.
   2. Stockpile each gradation separately on clean, non-contaminated surfaces.
C. Fine Aggregates: ASTM C33.
   1. Clean, hard, durable, uniformly graded mineral aggregate particles free from injurious amounts of silt, shale, coal, organic matter, or other deleterious substances.
   2. Stockpile each gradation separately on clean, non-contaminated surfaces.

D. Fly Ash: ASTM C618, Class C.

E. Water: potable, fresh, clean, and not detrimental to concrete.

F. Admixtures:
   2. Chemical Admixtures: ASTM C494:
      b. Type B – Retarding.
      c. Type C – Accelerating.
      d. Type D – Water Reducing and Retarding.
      e. Type E – Water Reducing and Accelerating.
      f. Type F – Water Reducing, High Range.
      g. Type G – Water Reducing, High Range and Retarding.
      h. Hydration Control: Delvo Stabilizer manufactured by BASF Construction Chemicals, LLC, or approved equal.
   3. All admixtures to be supplied from the same manufacturer and used in accordance with manufacturer’s recommendations.
   4. Do not use calcium chloride or admixtures containing chloride ions of any type under any circumstances.
   5. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

G. Flowable Mortar: Comply with IDOT 2506.02.

2.02 CONCRETE MIX

A. Concrete Mix: Iowa DOT Standard Specifications Class C-4 WR-C20, air-entrained. Comply with requirements of Materials I.M. 529 and ASTM C94.
   1. Ensure compatibility of all material combinations.
   2. Maximum water / cement ratio: 0.43.
   3. Minimum compressive strength: 4,000 psi at 28 days.

B. Consistency and workability: Proportion concrete to produce a mixture, suited to placement methods, which will work readily into corners and angles of forms and around reinforcement and embedded items.
   1. Slump:
      a. Use minimum practical. Vary within limits given to suit placement conditions.
      b. Do not increase slump by addition of water in excess of design mix quantity or maximum water / cement ratio.
      c. Minimum slump: 1 inch.
      d. Maximum slump without use of high-range water reducing admixture: 4 inches.
      e. Water reducing admixture(s) will be permitted to obtain required consistency and improve workability with Engineer’s approval.
      f. Hydration control admixture will be permitted to prolong required consistency and workability with Engineer’s approval.
   2. Air Content:
      a. Use an approved air entraining agent.
      b. Use target entrained air content of 6 percent with a tolerance of 1.5 percent when measured at placement location and prior to consolidation.
2.03 CONCRETE ACCESSORIES

A. Bonding Agent: Three-component bonding agent comprised of epoxy, combined with Portland cement for placing fresh concrete to existing concrete substrates.
   1. Armatec 110 manufactured by Sika Corporation
   2. Duralprep AC by Euclid Chemical Company
   3. Or Equal

B. Epoxy Bonding System: ASTM C881, type as required by project conditions.


D. Chemical Curing and Hardener:
   2. Magnesium Fluorosilicate solution designed for densification of cured concrete slabs. Use hardener compatible with other specified floor treatments and curing compounds.

E. Non-Shrink Grout: ASTM C1107; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
   1. Minimum Compressive Strength at 48 Hours: 2,400 psi.
   2. Minimum Compressive Strength at 28 Days: 7,000 psi.

F. Curing Materials: Comply with requirements of Section 03 39 00.

2.04 JOINT DEVICES AND MATERIALS

A. Joint Filler: Highly resilient polyethylene foam conforming to ASTM D7174, ASTM D5249 Type II, and ASTM 1752 Section 5.1 to 5.4.

B. Sealant and Primer: As specified in Section 07 92 00.

PART 3 EXECUTION

3.01 QUALITY ASSURANCE

A. General:
   1. Perform Work of this Section in accordance with all applicable, current ACI specifications and requirements.
   2. Acquire cement from same source and aggregate from same source for entire Project. Source shall be the same source as used to qualify mixes for initial mix submittals.
   3. Follow recommendations of ACI 305R when concreting during hot weather.
   4. Follow recommendations of ACI 306R when concreting during cold weather.
   5. Provide adequate control for measuring materials.

B. Owner will retain the services of and pay for qualified independent testing laboratory. Responsibility of testing laboratory will include:
   1. Obtaining and preparing samples and performing laboratory testing specified.
   2. Providing reports to Owner giving information on materials, concrete design mixes, and testing performed.
C. Cooperate with and provide access to Owner’s field-testing personnel for taking concrete samples.
   1. Number and frequency of tests will be determined by Owner.
   2. General testing sequence for concrete when delivered to site:
      a. Conduct slump test to confirm conformance to specifications. Repeat slump test if water is added to the concrete mix.
      b. Conduct air test to confirm conformance to specifications.

D. Contractor qualifications: Use qualified personnel or subcontractor with experience and proficiency in installing products specified in this Section.

3.02 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with Work of this Section.

3.03 PREPARATION

A. Formwork: Comply with Section 03 10 00.

B. Concrete Reinforcement: Comply with Section 03 20 00.

C. Coordinate placement of joint devices and other embedded items with erection of concrete formwork and placement of form accessories.

D. Confirm all embedded items are in place, in the proper location, and sufficiently secured to prevent movement during placement and consolidation of concrete.

3.04 BATCHING

A. Ensure batching plant is Iowa DOT Standard Specifications calibrated and approved.

B. Prior to batching concrete, obtain representative samples from material stockpiles daily to determine moisture content of coarse and fine aggregates. Adjust water volume accordingly to account for moisture content of aggregates.

C. Allow Owner opportunity to test concrete at batch plant or immediately after delivery at site as requested.

D. Owner will test concrete after batching for:
   1. Slump, air content, and temperature prior to addition of high-range water reducing admixture.
   2. Slump, air content, and temperature after addition of high-range water reducing admixture.
   3. Average compressive strength at 3, 7, and 28 days.

3.05 MIXING

A. Ensure concrete is uniform in composition and consistency.

B. Do not add water to concrete during delivery or at project site except as follows:
   1. If concrete batch ticket indicates that the quantity of water in the mix design was not fully added at the plant, then the quantity of water may be added under the approval and direct supervision of Engineer.
   2. If approval is granted to add additional mixing water at site, mix batch at least 30 revolutions of the drum at mixing speed.
3.06 PLACEMENT

A. Place concrete in accordance with ACI 304R for normal ambient conditions.
   1. Normal ambient conditions are defined as 40 degrees F to 75 degrees F.
   2. When ambient conditions are outside the normal range procedures identified in this specification Section 3.12 Hot Weather Requirements or Section 3.13 Cold Weather Requirements shall apply.

B. Place concrete for floor slabs in accordance with ACI 302.1R.

C. Notify Engineer not less than 24 hours prior to commencement of placement operations.

D. Moisten slab-on-grade granular substrate to saturated-surface-dry condition immediately prior to concrete placement.

E. Place concrete continuously and without construction joints except as noted on plans.
   1. Do not allow more than 20 minutes between depositing adjoining concrete within each section.
   2. Place concrete while preceding layer or adjoining area is still plastic to avoid cold joints.

F. Maintain temperature of concrete during placement between 50 degrees F and 90 degrees F.

G. Guide concrete into position and prevent segregation during placing.
   1. Do not allow concrete to drop freely more than 3 feet above placement location.
   2. Use tremied or pumped concrete to provide proper placement.

H. Maintain formwork in proper orientation without separating, shifting, distorting, or moving out of position during concrete placement.

I. Place new concrete with tightly closed margins free of voids and protrusions including form leakage and other disfigurements.

J. Consolidate concrete with mechanical vibrating equipment to eliminate all voids and fully encapsulate reinforcing steel. Use equipment and procedures for consolidating concrete recommended by ACI 301.
   1. Do not use vibrators to transport concrete inside forms.
   2. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator.
   3. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer.
   4. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
   5. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

K. Deposit and consolidate concrete for floors and slabs in a continuous operation.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Begin initial floating using bull floats or other means to form a uniform and open-textured surface plane free of humps or hollows before excess moisture or bleed-water appears on the surface.
   5. Do not further disturb slab surfaces before starting finishing operations.

L. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains as indicated on Drawings.

M. Protect freshly placed concrete from damage due to sun, cold weather, running water, construction operations, and other causes until properly cured.
3.07 FINISHING

A. Finish surfaces to be free of protrusions and depressions, bug holes, honeycomb, finishing equipment marks, and form laitance.

B. Flat work surfaces to be floated smooth and uniform troweled smooth or light broom finished. Exterior slabs: medium broom finish.

C. Lubricating concrete surface by sprinkling water by spray, brush, or other methods to afford greater ease in finishing operation is not allowed.

D. After removal of forms, rub surface of newly placed concrete to eliminate form lines and minor surface voids.

E. Patch honeycomb, aggregate pockets, voids, and holes.
   1. Chip out until sound concrete is exposed to a minimum depth of 1 inch.
   2. Prepare patching sand / cement patching mortar. Vary proportions of cement as necessary to match color of adjacent concrete.
   3. Saturate surfaces with water and fill cavities with patching mortar.

3.08 CURING

A. Curing Interior Floors:
   1. Apply cure and seal membrane in accordance with Section 03 39 00 Concrete Curing.

B. Concrete Components Other than Floors
   1. Maintain forms on vertical surfaces and keep horizontal concrete surfaces continuously wet for 7 days after placing.
   2. Wet cure horizontal surfaces
      a. Use clean, non-staining absorptive mats with water curing.
      b. Maintain the surface continually wet for a period of no less than 7 days.

3.09 WASHING WATER

A. Provide an adequate supply of washing water for cleaning concrete-mixing equipment, discharge chutes, and placement equipment.

B. Provide means to retain water used for washing equipment at site. Do not allow wash water to leave site and flow onto adjoining properties or streets or flow into storm sewers.

3.10 LOADING

A. Do not load structural members:
   1. Until concrete reaches prescribed 28-day strength.
   2. Less than ten days after concrete placement.

3.11 DEFECTIVE CONCRETE

A. Test Results: The testing agency shall report test results in writing to Engineer and Contractor within 24 hours of test.

B. Defective Concrete: Concrete with excessive honeycombing, embedded debris, or concrete not conforming to required lines, details, dimensions, tolerances, or specified requirements.

C. Repair or replacement of defective concrete will be determined by Engineer. Contractor to bear the cost of additional testing when defective concrete is identified.
D. Do not patch, fill, touchup, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

E. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.

F. Patch imperfections as directed.

3.12 HOT WEATHER REQUIREMENTS

A. Comply with ACI 305R unless otherwise specified herein below.

B. Hot weather conditions are deemed to exist when the temperature in the forms is 75 degrees F or above, or a combination of high air temperature, low relative humidity and wind velocity impair the quality of fresh or hardened concrete; take protective measures for mixing, transporting and placing concrete in accordance with ACI 305.

C. Record concrete temperature at time of discharge.
   1. The temperature of concrete at place of discharge may not exceed 85 degrees F.
   2. If ice is used to lower temperature, place crushed, shaved or chipped ice directly into mixer as part or all of the mixing water; mix until ice is completely melted.

D. Do not add water that will cause proportions to exceed the maximum water-cement ratio.
   1. Notify Engineer before adding any water to concrete mix.
   2. Record the quantity of water added to the concrete at the job site.

E. Placing Concrete
   1. Discharge concrete within 45 minutes or 100 revolutions, whichever occurs first, after the first mixing of cement and aggregates.
   2. Place concrete promptly upon arrival.
   3. Protect concrete from direct sunlight; keep forms covered and moist by means of direct misting or the application of continuously wetted burlap or cotton mats for a minimum of 24 hours. Windbreaks and/or sunshades shall be provided as directed by Engineer.

F. When forms are removed, provide wet cover to newly exposed surfaces to avoid exposure to hot sun and wind.

G. Continue specified water curing methods for 10 days; leave covering in place 4 additional days; do not permit alternate wetting and drying cycles.

H. For slabs on grade, beam and deck concrete, and other horizontal placements, protect the surface between finishing operations using one or more of the following methods:
   1. Careful use of a fog nozzle.
   2. Spreading and removing polyethylene sheeting between finishing operations.
   3. Application of monomolecular film after the strike-off.

I. During extremes in weather, floor slabs shall not be cast unless the slab is protected by a roof and other suitable protective measures are provided. After curing has been completed, the floor shall be exposed to the air for 48 hours prior to allowing traffic on the floors.

3.13 COLD WEATHER REQUIREMENTS

A. Comply with ACI 306R unless otherwise specified below.

B. Cold weather is defined any time when daily temperature is 40 degrees F or lower during placement and the protection period. If at any time during the progress of the work, the temperature drops below 40 degrees F, the Contractor shall make suitable provisions to protect the concrete by use of insulation materials such as blankets, mats, and equipment for providing artificial heat.
C. Protect concrete surfaces from freezing for at least 24 hours after placement.

D. All surfaces in contact with newly placed concrete, including formwork, reinforcement and subgrade, must be above 35 degrees F.

E. Use preparation methods capable of producing concrete with a temperature not more than 85 degrees F, and not less than 55 degrees F, at the time of placement.

F. Do not heat concrete ingredients to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, within specified temperatures. (Do not heat water in excess of 140 degrees F.)

G. Concrete shall have a temperature of not less than 55 degrees F when placed; mix concrete at a temperature between:
   1. 60 degrees F and 70 degrees F when outside air temperature is above 30 degrees F.
   2. 65 degrees F and 75 degrees F when outside air temperature is between 0 degrees F and 30 degrees F.
   3. 70 degrees F and 80 degrees F when outside air temperature is below 0 degrees F.

H. Follow concrete placement with insulated curing blankets or other readily movable coverings, so only a few feet of concrete are exposed to outside air at any time.

I. Maintain temperature and moisture conditions specified in all parts of the newly placed concrete by covering, insulating, housing or heating; arrange for protection methods in advance of placement.

J. Maintain concrete at a temperature of not less than 55 degrees F nor more than 70 degrees F for a period of three (3) days after placement.

K. Place a thermometer accurate to plus or minus 2 degrees F under the curing blanket. Additional insulation to be supplied as required to maintain temperature above 55 degrees F.

L. After the curing period, do not permit the temperature of the exposed surface to drop faster than 30 degrees F in 24 hours.

M. Do not remove forms during initial protection period.

N. Protect insulation against wetting that will impair its insulating value using moisture-proof cover material; keep insulation in close contact with concrete.

O. Construct enclosure to withstand wind and snow loads and be reasonably airtight; provide sufficient space between concrete and enclosure to permit free circulation of heated air.

P. Use vented heaters; do not permit heaters to heat or dry concrete locally. Unvented heaters which produce carbon dioxide as by-products not permitted in buildings during casting operations or for the following 36 hours. If heaters are used, take precautions to prevent drying of the slab through use of water jackets or other suitable methods. Provide supplemental humidification equipment when using applied heat.

Q. Maintain relative humidity above 40 percent within heated enclosures before construction supports are removed.

R. Monitor temperature to ensure concrete is kept within specified limits, recording time and concrete temperature every 8 hours.

S. Ensure concrete has developed necessary strength before removing forms; provide additional test cylinders with the same protection as the structure they represent to verify concrete strength before construction supports are removed.
T. If water curing is used, terminate at least 12 hours before end of temperature protection period. Permit concrete to dry.

U. After the required protection period, gradually reduce concrete temperature within an enclosure or insulation at a rate not to exceed 20 degrees F per day until outside temperature has been reached.

3.14 CLEANUP AND RESTORATION

A. Completely remove materials and debris from site for work done in this Section.

B. Dispose of materials in accordance with state and local laws governing proper disposal of construction materials.

** END OF SECTION **
SECTION 03 39 00

CONCRETE CURING

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Initial and final curing of horizontal concrete surfaces.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.
B. Section 03 10 00 – Concrete Forms and Accessories.
C. Section 03 20 00 – Concrete Reinforcement.
D. Section 03 30 00 – Cast-in-Place Concrete.

1.03  REFERENCES

A. American Association of State and Highway Transportation Officials (AASHTO) M 182 – Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.
B. American Concrete Institute (ACI) 301 – Specifications for Structural Concrete for Buildings; current version.
C. American Concrete Institute (ACI) 302.1R – Guide for Concrete Floor and Slab Construction; current version.
D. American Concrete Institute (ACI) 305R – Guide to Hot Weather Concreting.
E. American Concrete Institute (ACI) 308 – Standard Practice for Curing Concrete; current version.

1.04  SUBMITTALS

A. Product Data: Provide data on curing compounds and moisture-retaining sheeting, including compatibility of different products and limitations.

1.05  MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2 PRODUCTS

2.01 WET CURING MATERIALS

A. Water Retaining Absorptive Cover
   1. Spun-bonded polyester geotextile fabric, minimum 7 ounces per square yard when dry.
   2. AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 8 ounces when dry.

B. Cover for Water-Retaining Absorptive Cover
   1. ASTM D2103 or ASTM D4397, polyethylene sheeting, minimum thickness 8 mils.
   2. Duct Tape: Polyethylene laminated cloth with natural rubber adhesive. Basis of Design: Scotch General-Purpose Cloth Duct Tape 393 by 3M or equal.

C. Curing Water: Potable.

2.02 MEMBRANE-FORMING CURING MATERIALS

A. Exterior Concrete Curing Compound
   1. Compliant with ASTM C309, Type 2, White Pigmented Resin.

B. Interior Concrete Curing and Sealing - Non-yellowing acrylic
   1. Compliant with ASTM C309 Type 1, Classes A and B and ASTM C 1315 Type 1, Class A.
   2. Acceptable Products:
      b. MasterKure CC 250 SB by BASF Master Builder.
      c. Diamond Clear by Euclid Chemical Co.

PART 3 EXECUTION

3.01 GENERAL

A. Quality Assurance: Perform Work in accordance with ACI 301 and ACI 302.1R.

B. Delivery, Storage, and Handling: Deliver materials in manufacturer's sealed packaging.

3.02 EXAMINATION

A. Verify that substrate surfaces are ready to be cured.

3.03 HORIZONTAL SURFACES – WET CURE

A. All cast in place concrete shall be wet cured except floor slabs which may be treated with cure and seal membranes.

B. Wet curing shall be performed in accordance with ACI 308.

C. Ponding: Maintain 100 percent coverage of water over horizontal surface continuously for 7 days.

D. Spraying: Spray water over floor slab areas and maintain wet for 7 days.

E. Absorptive Moisture-Retaining Sheet: Saturate burlap-polyethylene and place burlap side down over floor slab areas, lapping ends and sides; maintain in place for 7 days.
3.04 INTERIOR FLOOR SLABS – CURE AND SEAL

A. Cure interior floor slabs with the specified cure and seal compound in accordance with the manufacturer recommendation immediately following achieving the specified finish.

B. Form a continuous membrane surface comprised of 2 coats with a maximum application rate of 300 square feet per gallon always maintaining wet application edges along successive application passes.

C. Provide a light back roll over spray laps providing uniform coverage free of lap marks.

D. Redistribute any puddling of sealer with back rolling techniques.

E. Protect sealer from wetting for a minimum of 12 hours after application.

3.05 PROTECTION OF FINISHED WORK

A. Do not permit traffic over unprotected floor surface.

3.06 FIELD QUALITY CONTROL

A. Method and application of curing shall account for concrete temperature, air temperature, relative humidity, and wind velocity.

B. When evaporation rates exceed 0.2 pounds per square foot per hour, precautions shall be taken to prevent cracking of the plastic shrinkage. Use Figure 2.1.5 of ACI 305R for evaluating.

** END OF SECTION **
SECTION 04 05 00
MORTAR AND MASONRY GROUT

PART 1  GENERAL

1.01  SUMMARY OF WORK
A. Section includes mortar and grout for masonry.

1.02  RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 04 20 00 – Unit Masonry.

1.03  REFERENCES
A. American Society for Testing and Materials (ASTM) International:

B. International Masonry Industry All-Weather Council (IMIAC):

C. The Masonry Society (TMS):
   1. ACI 530 - Building Code Requirements for Masonry Structures.
   2. ACI 530.1 - Specifications for Masonry Structures.

1.04  SUBMITTALS
A. Product Data: Submit mortar product data including cement, lime, and mortar color to be used.

B. Samples: Submit one fully cured sample of mortar used for exterior stonework, illustrating the mortar color and color range.

C. Installation Instructions: manufacturer’s published instructions, including any special installation instructions relating to this Project.
1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement: ASTM C150, Type 1.

B. Mortar Aggregate: ASTM C144, standard masonry type.

C. Hydrated Lime: ASTM C207, Type S.


E. Water: Clean and potable.

F. Masonry cement not permitted.

2.02 MORTAR COLOR

A. Use colored mortar for masonry stonework. Color as selected by Owner from manufacturer’s standard colors.

B. Use standard gray mortar for concrete unit masonry and all other purposes.

2.03 MORTAR MIXING

A. Thoroughly mix Portland cement-lime mortar ingredients in accordance with ASTM C270.

B. Use Type S (1800 psi) mortar for all work, except where indicated otherwise.

C. Maintain sand uniformly damp immediately before mixing process.

D. Do not use anti-freeze compounds to lower the freezing point of mortar.

E. If water is lost by evaporation, re-temper only within two (2) hours of mixing.

F. Use mortar within two (2) hours after mixing at temperatures 90 degrees F, or two-and-one-half (2-1/2) hours at temperatures under 47 degrees F.

2.04 GROUT MIXING

A. Bond beams and Lintels: 3,000 psi strength at 28-days, 8- to 10-inch slump; premixed type in accordance with ASTM C94 or mixed in accordance with ASTM C476 course grout.

B. Thoroughly mix grout ingredients in quantities needed for use in accordance with ASTM C476 course grout.

C. Do not use anti-freeze compounds to lower the freezing point of grout.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install mortar and grout to requirements of Section 04 20 00.

** END OF SECTION **
PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Section includes concrete unit masonry interior wythe, reinforcement, anchorage, and accessories.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 04 05 00 – Mortar and Masonry Grout.

C. Section 05 50 00 – Metal Fabrications.

D. Section 08 11 00 – Steel Doors & Frames.

E. Section 08 36 00 – Sectional Overhead Door.

1.03  REFERENCES

A. American Society of Civil Engineers (ACI) International:
   1. ACI 530 - Building Code Requirements for Masonry Structures.
   2. ACI 530.1 - Specification of Masonry Structures.

B. American Society for Testing and Materials (ASTM) International:
   6. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   7. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   10. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
   11. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units.
   12. ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

C. International Code Council:
1.04 SUBMITTALS
   A. Product Data: Concrete masonry units, mortar, and masonry accessories.
   B. Masonry Shoring Systems: Submit shoring and falsework systems intended to support masonry lintels during construction.

1.05 QUALITY ASSURANCE
   A. Perform Work in accordance with ACI 530 Building Code Requirements for Masonry Structures and ACI 530.1 Specifications for Masonry Structures.

1.06 MOCKUP
   A. A mockup panel including concrete unit masonry as a backup is required to establish the accepted wall assembly system for coordination of materials and appearance.
   B. Construct masonry wall mockup panel sized 8 feet long by 6 feet high, including masonry, mortar, accessories, structural backup, and flashings.
   C. Mockup to be constructed on site and approved by Owner prior to starting masonry work.
   D. Incorporate accepted mockup as part of Work.

1.07 MEASUREMENT AND PAYMENT
   A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS
   A. Hollow Block Units: ASTM C90, Grade N, normal weight, 1,900 psi minimum compressive strength on the net area.
   B. Masonry Units: Modular sized to thickness as indicated on Drawings; provide special units for 90-degree corners, bond beams, sash units, end units, and lintels.

2.02 CONCRETE MASONRY MORTAR
   A. Concrete Unit Masonry Mortar: ASTM C270, Type S, normal weight, 1,800 psi minimum compressive strength.

2.03 REINFORCEMENT
   A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed billet bars; uncoated.
   B. Joint Reinforcement for Single Wythe Interior Walls: Single width, ladder-type, ASTM A951/A951M, steel wire 0.148-inch diameter side rods with 0.148-inch diameter cross ties, width as required to provide not more than 1 inch and not less than 1/2-inch mortar coverage, hot dip galvanized.
      1. Manufacture and Model:
         a. Hohmann and Barnard Model #220 Ladder-Mesh.
         b. Or approved equal.
2.04 FLASHING
   A. Stainless Steel: ASTM A240/240M, Type 304, 26-gauge, smooth finish.

2.05 ACCESSORIES
   B. Joint Filler: Closed-cell polyethylene or polyurethane form compliant with ASTM C1330, oversized 50 percent of joint width; self-expanding.
   C. Masonry cleaning solution: Not harmful to masonry work or adjacent materials.
      1. Acceptable Product: Sure Klean 600 manufactured by Prosoco or equal.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify field conditions are acceptable and are ready to receive work.
   B. Verify items provided by other sections of work are properly sized and located.
   C. Verify built-in items are in proper location and ready for roughing into masonry work.

3.02 PREPARATION
   A. Direct and coordinate placement of metal anchors, including embedded plates.
   B. Establish elevations and proper coursing to meet elevation requirements.
   C. Verify rough opening sizes for window, doors, and mechanical louvers. Notify Engineer if opening sizes required for opening frames are different from plan dimensions or disrupt masonry bond layout.
   D. Construct shoring and falsework systems necessary for supporting masonry lintels during construction as follows:
      1. Erect falsework to be true, resulting in masonry openings to be horizontally level, vertically plumb, constructed with right angles, and positioned at proper elevation.
      2. Shoring shall have adequate strength and be properly braced to sustain the imposed masonry loads without shifting or deflecting during masonry assembly.

3.03 COURSING
   A. Place masonry to elevations and positions indicated in plan details and notes.
   B. Maintain masonry courses in uniform modular dimensions. Joints shall have equal and uniform dimension throughout entire wall systems.
   C. Coordinate coursing with fabricated steel to ensure finished elevations of masonry coincide properly with fabricated and erected elevations of steel structural components.

3.04 MASONRY LAYOUT AND BOND
   A. Concrete masonry encapsulates and conceals structural steel components. Maintain a consistent wall bond layout through the location of concealed columns.
   B. Lay concrete masonry units in running bond for all exposed block walls. Course one block unit and one mortar joint to equal 8 inches.
3.05 WALL CONSTRUCTION

A. Lay masonry units in full bed joints of mortar cover the full-face shell on both faces.
B. Head joints shall be uniform and constructed the full depth of the face shell.
C. All mortar joints to be tooled uniformly concave, including concealed joints.
D. Joints shall not be excessively furrowed or surfaced with thin layers using a buttering process.
E. Remove excessive mortar from masonry unit surface and inside reinforced cells as work progresses up the plane of the wall.
F. Provide a full bond overlap at intersections of external and internal corners unless the intersection abuts an expansion joint.
G. Do not shift or tap masonry units after mortar has achieved initial set. If units require movement after initial set, remove unit from the work and reset it with new mortar.
H. Perform job site cutting of masonry units with proper tools to ensure straight, clean, unchipped edges. Take care to prevent breaking masonry unit corners or edges.
I. Install masonry flashing as shown on the Drawings, at base of wall and above lintels.

3.06 LINTEL CONSTRUCTION

A. Examine shoring for support of masonry lintels ensuring it is uniform and placed to provide a level lintel bottom.
B. Assemble masonry units in lintels to create a full interior void free of mortar projections and other obstructions to proper flow of grout.
C. Lintels with bottom steel plates shall have masonry constructed to allow grout to flow freely to engulf anchor studs on the plates.
D. Position bottom reinforcing steel as low in the masonry section as possible while maintaining enough clearance to allow grout to flow under the reinforcing bar.
E. Position top steel in lintels such that top of steel is 1 to 1-1/2 inches below the top of the upper masonry course.
F. Provide continuous lintel horizontal reinforcing across entire lintel span plus 12 inches on each end. Terminate each horizontal lintel bar with a 90-degree standard hook lapped into a vertically reinforced cell.
G. Maintain vertical reinforcing spacing across lintel spans with the bottom ends of all vertical reinforcing terminating at bottom of lintel with a 90-degree standard hook.
H. Maintain shoring under lintels for a minimum period of 14 days after lintel is fully grouted. Shoring must be maintained for 28 days if lintels are required to carry any more load than their self-weight.

3.07 REINFORCING

A. Position reinforcing at center of wall for singly reinforced cells and 3/4 inch in from the face shell in doubly reinforced cells.
B. Maintain proper position of bars utilizing bar spacers.
C. Full height, high lift grout reinforcing is preferred, utilizing full height reinforcing steel.

D. If low lift grouting techniques are utilized in construction, reinforcing bar splices shall be at least 48 bar diameters in length and minimum of 36 in any case. Spliced bars shall be wire tied in place, aligned with the lower bar, and maintained at the same distance in from the face of masonry.

3.08 GROUTING

A. General
   1. Install grout in accordance with ACI 530.
   2. Grout to be provided from a ready-mix truck at the site or from a silo located on site.
      a. Test grout slump. Must be 8- to 11-inch slump.
      b. Place each grout batch no more than 60 minutes from preparation.

B. Placement – High Lift Technique
   1. Use of high lift grouting techniques is encouraged and preferred.
   2. Place a small inspection hole at the base of the grouted cell to allow air to escape and ensure grout fills the entire void. Place hole where it will be concealed in final construction.
   3. Insert high lift grouting tube full depth into cell without displacing reinforcing.
   4. Pump grout into reinforced cells extracting the tube along with the top of grout fill.
   5. Consolidate grout by rodding or vibration into masonry cores and lintel cavities to eliminate all voids.
   6. Trim and finish grout inspection holes after grout achieves its initial set.

C. Placement – Low Lift Technique
   1. Place and consolidate grout fill without displacing reinforcing.
   2. Consolidate grout by rodding and vibration into masonry cores and lintel cavities to eliminate voids.
   3. Use a low velocity vibrator with 3/4-inch head. The vibrator is activated for one to two seconds in each grout cell.
   4. Do not grout in lifts greater than 12 inches without consolidating. Consolidate grout within 10 minutes after placement and before its plasticity is lost.
   5. Terminate top of lift a minimum of 1-1/2 inch from mortar joint, except at opening or top of wall.

3.09 CAVITY CONSTRUCTION

A. The cavity behind masonry veneer is a continuation of the space behind siding on the upper wall. Furring z-channels extend into the masonry cavity to provide attachment for veneer masonry ties.

B. The base of masonry cavities shall be flashed at the base as detailed in the Drawings as part of the moisture weep system.

3.10 CONTROL JOINTS

A. Provide a reinforced vertical cell to each side of all control/expansion joints.

B. Do not continue horizontal joint reinforcement through control and expansion joints.

C. Terminate horizontal reinforcing with a 90-degree standard hook anchored into the vertically reinforced cell.

D. Use preformed control joint block units on both sides of control joint, unless shown otherwise on Drawings.

E. Install preformed control joint device in continuous lengths. Seal and butt joints in accordance with manufacturer’s instructions.
3.11 BUILT-IN WORK

A. As work progresses, build in metal door, window and louver frames, embedded plates, columns, and other items needed for completion of Project.

B. Install frames horizontally level and vertically plumb, laterally positioned as detailed on Drawings.

C. Bed anchors of metal door frames in mortar joints. Fill frame voids solids with grout. Fill adjacent masonry cores with grout a minimum 16 inches (2 cells) outside of framed openings.

D. Do not build in any organic materials subject to deterioration.

3.12 TOLERANCES

A. Maximum variation from unit to adjacent unit: 1/32 inch.

B. Maximum variation from plane of wall: 1/4 inch in 10 feet and 1/2 inch in 20 feet or more.

C. Maximum variation from plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.

D. Maximum variation from level coursing: 1/8 inch in 3 feet.

E. Maximum variation of joint thickness: 1/8 inch in 3 feet.

F. Maximum variation from cross-sectional thickness of walls: plus or minus 1/4 inch.

3.13 CLEANING

A. Remove excess mortar and mortar smears as work progresses.

B. Replace defective mortar. Match adjacent work.

C. Clean soiled surfaces with cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.14 PROTECTION OF WORK

A. Protect exposed external corners subject to damage.

B. Protect base of walls from mud and mortar splatter.

C. Protect masonry and other items built into masonry walls from mortar droppings and staining caused by mortar.

D. Protect tops of masonry work with waterproof coverings secured in place without damaging masonry. Provide coverings where masonry is exposed to weather when work is not in progress.

** END OF SECTION **
PART 1  GENERAL

1.01  SUMMARY OF WORK
A. Section includes cast stone forming a sill above the stone base and trim around for door, window, and louver openings.

1.02  RELATED SECTIONS
A. Section 04 05 00 – Mortar and Masonry Grout.
B. Section 04 20 00 – Unit Masonry.
C. Section 04 85 00 – Stone Masonry Veneer.
D. Section 05 40 00 – Cold-Formed Metal Framing.

1.03  REFERENCES
A. American Concrete Institute:
   1. ACI 530 - Building Code Requirements for Masonry Structures.
   2. ACI 530.1 - Specifications for Masonry Structures.
B. ACI 318 - Building Code Requirements for Reinforced Concrete.
D. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Reinforced Concrete.
G. ASTM C595 - Blended Cement.
H. ASTM C1157 - Hydraulic Cement.
I. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volume Method.
J. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
M. ASTM C426 - Standard Test Method for Linear Shrinkage of Concrete Masonry Units.
O. ASTM C618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.


1.04 SUBMITTALS

A. Product Data: Submit data on architectural cast stone units, mortar products, and other accessories.

B. Samples:
   1. Submit cast stone sample panels 6-inch square and one sectional sample of each component representing the size, color, and texture.
   2. Submit mortar color samples.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in fabrication of architectural cast stone element for incorporation into masonry construction.

B. Installer: Qualified stone mason extensively experienced in construction of masonry assemblies utilizing architectural cast stone elements in commercial-quality construction.

1.06 MOCKUP

A. Construct architectural cast stone wall mockup illustrating sill elements and openings including flashings.

B. The mockup shall represent proper joint configuration in architectural cast stone elements to be used throughout the project.

C. Locate the mockup along an east-west wall return at the back side of the building.

D. Retain accepted mockup as completed Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Mark architectural cast stone units with identification marks referencing them to the shop drawings.

B. Deliver architectural cast stone units palleted, protected, and secured to enable shipping and handling on site without damaging units.

C. Upon arrival, check all architectural cast stone for damage and report to carrier, noting damage on delivery document.

D. Handle architectural cast stone carefully and avoid chipping edges or corners.

E. Store architectural cast stone off the ground surface and protect it from discoloration during storage on site.

F. Provide ventilation to prevent condensation from forming on architectural cast stone.
1.08 ENVIRONMENTAL REQUIREMENTS

A. Cold Weather Requirements: In accordance with ACI 530.1 when ambient temperature or temperature of masonry units is less than 40 degrees F.

B. Hot Weather Requirements: In accordance with ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than 90 degrees F with wind velocity greater than 8 mph.

1.09 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 ARCHITECTURAL CAST STONE UNITS

A. Dry Cast: Manufactured from zero slump concrete, vibration tamped. Match the production materials to the provided product samples.

B. Cast Stone Materials
   1. Portland cement: Type I or Type III, white, buff, and/or grey, ASTM C150.
   2. Coarse aggregates: ASTM C33 except for its gradation.
   4. Colors: Inorganic iron oxide pigments (none to be carbon based) compliant with ASTM C979
   5. Admixtures:
      a. ASTM C260 for air-entraining admixtures.
      b. ASTM C494 Types A - G for water reducing, retarding, accelerating and high range admixtures.
      c. Do not use ASTM C618 mineral admixtures of dark and variable colors in surfaces intended to be exposed to view.
      d. Other admixtures: Suitable for use in concrete by proven field performance or through laboratory testing.
   7. Reinforcing Bars: ASTM A615; Grade 60.

C. Production Tolerances:
   1. Do not deviate cross section dimensions by more than plus or minus 1/8 inch from approved dimensions.
   2. Do not deviate length of units by more than length / 360 or plus or minus 1/8 inch, whichever is greater, not to exceed plus or minus 1/8 inch.
   3. Do not exceed maximum length of any unit by 15 times the average thickness of such unit unless otherwise approved by the Engineer.
   4. Warp, bow or twist of units shall not exceed length / 360 or plus or minus 1/8 inch, whichever is greater.
   5. Location of dowel holes, anchor slots, flashing grooves, false joints and similar features; on formed sides of unit, 1/8 inch, on unformed sides of unit, 3/8-inch maximum deviation.

D. Spanning Capabilities
   1. Headers for window and door surround trim are positioned beneath a siding system that is self-supported. Loading on architectural cast stone is self-weight and flashing only.
   2. Reinforce door and window headers with a span 6 feet-8 inches or less to be self-spanning or include connections to the backup masonry lintel to assist in spanning.
   3. Conceal connections used to assist in spanning behind finishes or frames.

E. Basis of Design
   1. Dry Cast Architectural Cast Stone manufactured by Edwards Cast Stone Company, Dubuque, IA.
2.02 QUALITY CONTROL

A. The following deficiencies in the architectural cast stone form the basis for rejection of the product:
   1. Bug holes or air voids on finished surfaces.
   2. Ragged or chipped edges on formed edges.
   3. Stains on exposed faces from foreign substances.
   4. Twist, warp, out of square or bow exceeding tolerances.
   5. Areas of rough texture or smoothness not matching sample from 20 feet.
   7. Visible cracks exceeding 0.007 inch.
   8. Reinforcing shadows or exposure on face.
   9. Rust on surface caused by staining, reinforcement or iron pyrites.
  10. Form marks or local depressions in excess of 0.030 inch.
  11. Out-of-plane or pie-shaped joints, or large or small joints out of tolerance.

2.03 MORTAR

A. Concrete Unit Masonry Mortar: ASTM C270, Type S
   1. Color matched to stone selected from manufacturer standards.

2.04 ACCESSORIES

A. Cast Stone Wall Ties
   1. Wall ties anchoring architectural cast stone to backup masonry shall be provided by the
      architectural cast stone manufacturer or shall be those recommended by the manufacturer for
      attachment to backup masonry.

B. Water Repellent
   1. Manufacturer recommended if architectural cast stone producer requires water repellent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify support work and site conditions are ready to receive work of this Section.

B. Verify openings have been suitably sized for a proper fit of cast stone surrounds. Do not proceed
   with work if architectural cast stone is not sized to properly fit openings.

C. Verify existing masonry is free of obstructions to proper placement of architectural cast stone.

3.02 PREPARATION

A. Establish lines, levels, and layout for architectural cast stonework to produce true lines that are true,
   horizontally level and vertically plumb.

B. Clean surfaces behind architectural cast stone of all projections or deleterious debris.

C. In sill locations where multiple units are to be installed, sort units and establish the layout so that
   variation between adjacent units is indiscernible.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions, ACI 530.1 and approved submittals.

B. Install anchors into backup masonry in conjunction with construction of architectural cast stone
   assemblies; center in joints with suitable cover to prevent exposing anchors to view.
C. Joints
   2. Joint Profile
      a. Slightly concave between architectural cast stone units.
      b. Brushed in accordance with Stone Masonry Veneer under sills.
   4. Vertical Head Joints
      a. Typical: Fill vertical head joints completely with mortar.
      b. Abutting Opening Vertical: Leave open for sealant.
      c. At Expansion Joints: Leave open for sealant.

D. Remove excess mortar immediately and completely from the surface of architectural cast stone.

E. Remove mortar fins and disfigurements prior to tooling mortar joints.

3.04 CLEANING

A. Clean architectural cast stone with installation, removing mortar smears and splatters completely throughout construction. Clean soiled surfaces together with the stone masonry after construction is complete.

B. Use synthetic bristle brushes and non-metallic tools in cleaning operations.

C. Flush cleaner off architectural cast stone masonry surface as soon as mortar residue is removable to minimize any etching.

3.05 PROTECTION OF INSTALLED CONSTRUCTION

A. Protect stonework throughout the progression of the Work. Provide barrier to damage from construction operations during the period of mortar curing.

B. Cover stonework during temporary storage on site, at end of working day; during rainy weather, cover stonework exposed to weather with non-staining waterproof coverings, securely anchored.

** END OF SECTION **
SECTION 04 85 00
STONE MASONRY VENEER

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Section includes cut stone veneer on the base of exterior walls; metal anchors and accessories; and mortar.

1.02  RELATED SECTIONS

A. Section 04 05 00 – Mortar and Masonry Grout.

B. Section 04 20 00 – Unit Masonry.

C. Section 04 72 00 – Architectural Cast Stone

D. Section 05 40 00 – Cold-Formed Metal Framing.

1.03  REFERENCES

A. American Concrete Institute:
   1. ACI 530 - Building Code Requirements for Masonry Structures.
   2. ACI 530.1 - Specifications for Masonry Structures.

B. ASTM International:
   4. ASTM A666 - Standard Specification for Austenitic Stainless-Steel Sheet, Strip, Plate, and Flat Bar.
  10. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch. to 0.112 inches in Thickness.
1.04 SUBMITTALS

A. Product Data: Submit data on stone units, mortar products, reinforcement, wall tiles, anchors, flashings and weep accessories.

B. Samples:
   1. Submit a stone sample board and two full unit samples representing the full range of size, color, and texture, and markings.
   2. Submit mortar color samples.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in quarry and production of natural stone products suitable for use in building veneer applications.

B. Installer: Qualified stone mason extensively experienced in the construction of rustic stone commercial-quality construction.

1.06 MOCKUP

A. Construct stone wall mockup, full wall base height with a minimum width of six (6) feet including stone, reinforcing, wall ties, mortar, cast stone sill and flashings.

B. The mockup shall represent the spectrum of stone units to be included in the whole project assembled in a general random ashlar pattern.

C. Locate the mockup along an east-west wall return at the back side of the building.

D. Retain the accepted mockup as completed Work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver stone units palleted, protected, and secured to enable shipping and handling on site without damaging stone units.

B. Upon arrival, check all stone for damage and report to carrier, noting damage on delivery document.

C. Handle stone carefully. Avoid chipping edges or corners.

D. Store stone off the ground surface and protect it from discoloration during storage on site.

E. Provide ventilation to prevent condensation from forming on stone.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Cold Weather Requirements: In accordance with ACI 530.1 when ambient temperature or temperature of masonry units is less than 40 degrees F.

B. Hot Weather Requirements: In accordance with ACI 530.1 when ambient temperature is greater than 100 degrees F or ambient temperature is greater than 90 degrees F with wind velocity greater than 8 mph.

1.09 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2 PRODUCTS

2.01 STONE UNITS

A. Dolomite complying with ASTM C568 Performance Classification Class III, Table 1.

B. Mean Compressive Strength: 8,000 pound per square inch per ASTM C99 and ASTM C170.

C. Mean Absorption: 0.07 percent per ASTM C97.

D. Stone Unit Size
   1. Width: Full Bed Veneer
   2. Vertical Face Dimensions: 2 inches to 6 inches
   3. Horizontal Lengths: Random Cut

E. Color: Variant Gray-Buff inclusive of Rose Tone.

F. Facing Cut: Natural Rustic Rock Facing.

G. Basis of Design
   1. Chilton Ledge Stone quarried and produced by Halquist Stone, Sussex, WI 53089.

2.02 MORTAR

A. Concrete Unit Masonry Mortar: ASTM C270, Type S
   1. Color matched to stone selected from manufacturer standards.

2.03 ACCESSORIES

A. Wall Ties: Flexible Anchored Wall V-Ties
   1. Formed steel wire V-tie: 3/16-inch diameter wire comprised of Type 304 stainless steel conforming to ASTM A580.
   2. Tie Strap: 12-gauge (0.1094 inch) AISI Type 304 stainless steel conforming to ASTM A666, ASTM A480 and ASTM A240.
   3. Anchor Tie Screws: 1/4-14 x 3/4" ANSI Type 410 Stainless Steel Self Drilling Screw, Hex Washer Head conforming to ASTM C954.

B. Cavity Vent Weeps
   1. Vent through honeycombed polypropylene allowing passage of moisture while protecting the cavity from entry of debris and insects.
   2. Polypropylene conforming to ASTM D790B and ASTM D1238B.

C. Cavity Mortar Drop Weep Protection
   1. Use free-draining open-weave mesh devised to suspend dropped mortar and prevent mortar obstruction of drainage to cell vent weeps.
   2. Basis of Design: MortarNet manufactured by MortarNet Solutions, Portage, IN 46368, or equal.
D. Joint Filler
   1. Closed cell highly resilient polyolefin form conforming to ASTM D7174, ASTM D1752, and performance tested per ASTM D545.
   2. Maximum Compression: 13 pounds per square inch.
   4. Water Absorption: 0.25 percent maximum.

E. Cleaning Solution
   1. Manufactured product explicitly recommended by the manufacturer for use on unpolished limestone and dolomite.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify support work and site conditions are ready to receive work of this Section.

B. Verify openings have been suitably sized to prevent removal of placed stone.

C. Verify through wall flashing, foam insulation, and Z-furring channels have been installed and secured properly in place.

D. Verify the bottom of Z-furring is elevated above the base concrete to facilitate cavity drainage at base of the wall.

3.02 PREPARATION

A. Establish lines, levels, and coursing for stonework to generally produce a rustic random ashlar pattern utilizing the sizes of stone.

B. Clean stone prior to installation using high pressure water less than 1200 pounds per square inch and synthetic fiber bristle brushes, and detergent when required.

C. Cut stone at site to produce clean generally aligned faces while minimizing obstruction of cavity space behind the stone veneer.

D. Size stone units to fit dimensions and perimeter conditions.

E. Arrange stone pattern in color assortment to minimize large area visual variations on the overall wall appearance. Provide a uniform blend of stone unit sizes generally in a rustic random ashlar pattern.

F. Plan layout of stone units such that the top coursing will remain at a uniform height to receive a cast stone sill without requiring small pieces under the sill line to adjust for height. Plan termination of stone below the cast stone sill to provide full siding dimensions above the sill elevation.

3.03 INSTALLATION

A. General
   1. Bed the first course of stone firmly on the concrete base shaping the back side to provide a clear channel that facilitates drainage of accumulated mortar to the cell vent weeps.
   2. Place cell vent weeps firmly against the concrete base under stone masonry at intervals not to exceed 24 inches on center. Clear away all mortar or debris behind cell vent weeps to allow unobstructed water flow through the cell vents.
3. Place cavity mortar drop weep protection across the entire bottom of wall cavity to prevent dislodged mortar from obstructing drainage flashing and weeps.

4. Dolomitic stone is damaged by aggressive cleaning and therefore placement shall minimize errant mortar application on the face of stone. Mortar deposits on stone faces shall be thoroughly cleaned away during the process of installing stone units.

B. Placement
   1. Arrange stone units with a variation in color such that no single hue of stone coloration becomes concentrated in any one area in the extent of the wall. Finish stone masonry shall have intermixed coloration within adjacent units to eliminate a blotched general appearance.
   2. Arrange stone coursing in an ashlar bond with consistent joint width to provide a random rustic ashlar stone assembly.
   3. Set stone unit in full mortar setting bed to fully support stone over its bearing surface. Use setting buttons or shims as required to maintain correct joint width.
   4. Install masonry ties at every Z-furring location with spacing intervals not exceeding 16 inches.
   5. Mortar Joints
     a. Width: Joints shall have a uniform appearance with an average dimension not to exceed 3/4 inch with a minimum joint width dimension of 3/8 inch. Joints exceeding 3/4 inch shall appear in isolated locations only and not extend beyond a single unit in any one location.
     b. Alignment: Joints shall not be staked along more than 2 units without offsetting joints horizontally, except at expansion joint and opening termination locations. Horizontal head joint offsets shall be lapped by no less than 1/4 unit-length in adjacent courses.
     c. Finish: Surfaces of joint shall be packed tightly and tooled to a uniformly straight to slightly concave profile. After mortar reaches its initial set, brush to leave a sand texture finish without dislodging the mortar surface profile.
   6. Surface Plane: The finished masonry surface profile shall average to a true uniform plane where irregularities in individual units are corrected in the progression of constructing the overall masonry assembly.

3.04 CLEANING

A. The specified stone units are vulnerable to damage with aggressive cleaning or sustain contact with acid washes. Remove excess mortar from the face of masonry as work progresses with clean wet brush or wet rag. Do not allow mortar remnants that cannot be easily washed off to remain on the stone unit surface as work progresses.

B. Clean soiled surfaces with the specified masonry cleaner as directed by manufacturer for delicate limestone only after mortar has cured adequately to not sustain damage.

C. Use synthetic bristle brushes and non-metallic tools in cleaning operations.

D. Flush cleaner off the stone masonry surface as soon as mortar residue is removable to minimize any etching or color lightening that may occur from contact with acidic solutions.

3.05 PROTECTION OF INSTALLED CONSTRUCTION

A. Protect stone masonry throughout the progression of the work. Provide barrier to damage from construction operations during the period of mortar curing.

B. Cover stonework during temporary storage on site, at end of working day, and during rainy weather; cover stonework exposed to weather with non-staining waterproof coverings, securely anchored.

** END OF SECTION **
SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. This Section covers structural shapes, channels and angles, hollow structural sections, structural pipe, structural plates, bolts, connectors, and anchors.

B. Work under this Section shall cover furnishing and installing structural steel and appurtenances as described in this Section, and other applicable sections and as shown on the Drawings.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements.

B. Section 03 30 00 – Cast-in-Place Concrete.

C. Section 04 05 00 – Mortar and Masonry Grout.

D. Section 04 20 00 – Unit Masonry.

E. Section 05 31 00 – Steel Decking.

F. Section 05 40 00 – Cold-formed Metal Framing.

G. Section 05 50 00 – Metal Fabrication.

H. Section 07 30 00 – Steep Slope Roofing.

I. Section 09 90 00 – Painting.

1.03 REFERENCES

A. American Institute of Steel Construction:


W. American Welding Society (AWS) A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.


Z. SSPC: The Society for Protective Coatings:
   1. SSPC - Steel Structures Painting Manual.
   2. SSPC Paint 15 - Steel Joist Shop Paint.
   3. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
   4. SSPC SP 3 - Power Tool Cleaning.
   5. SSPC SP 6 - Commercial Blast Cleaning.

1.04 SUBMITTALS

A. Submit in accordance with specification Section 01 00 00.

B. Shop Drawings:
   1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
   2. Include erection drawings, elevations, and details where applicable.
   3. Indicate welded connections using standard AWS A2.4 welding symbols.
   4. Indicate net weld lengths.

C. Manufacturer's Mill Certificate: Certify products meet or exceed specified requirements.

D. Mill Test Reports: Submit indicating structural strength, destructive and non-destructive tests and analysis.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 STRUCTURAL STEEL

A. Structural W-Shapes: ASTM A572; Grade 50.

B. Structural M-Shapes: ASTM A529; Grade 50.

C. Channels, Plates, and Angles: ASTM A36/A36M.

D. Hollow Structural Sections: ASTM A500, Grade B.

E. Steel Pipe: ASTM A53/A53M, Grade B.

F. Sheet Steel: ASTM A653/A653M, Grade 33 Structural Quality with galvanized coating.

G. Bolts: ASTM A325; Type 1.
   1. Finish: Hot-dipped galvanized per ASTM A153/A153M.

H. Nuts: ASTM A563 heavy hex type.
   1. Finish: Hot-dipped galvanized per ASTM A153/A153M.

I. Washers: ASTM F436; Type 1.
   1. Finish: Hot-dipped galvanized per ASTM A153/A153M.

J. Welding Materials: AWS D1.1; type required for materials being welded.
K. Welded Anchor Studs:
   1. AWS D1.1; Type B Headed Anchor Studs; Type C Deformed Steel Bar Anchors.
   2. Cold-Drawn Steel Conforming to ASTM A108 or ASTM A29 Grades 1010 through 1020.

L. Anchor Bolts – Adhesive Anchors
   1. Epoxy adhesive compliant with ASTM C881, Type I to IV, Grade 3, Class B or C or manufacturer’s equal proprietary adhesive.
   4. Washers – Carbon Steel ANSI B18.22A Type A galvanized per ASTM A153; Stainless Steel ASTM A240, Type 304.

2.02 FABRICATION

A. Fit and shop-assemble items in largest practical sections for delivery to site. Fit at site without field damage to the shop-applied coating system.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by intermittent welds and plastic filler or continuous welds as indicated on Drawings.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

G. Fabricate concrete-embedded weldments to be interconnected with rods in pairs to assist in placing embedded weldments plumb and level and to ensure embedded weldments are properly mated to guard rails that will be mounted to them.

2.03 SHOP APPLIED FINISHES – STEEL

A. Preparation and finish painting of steel fabrications to be done completely in the shop and touched up in the field.

B. Clean surfaces free of rust, scale, grease, and foreign matter to a level compliant with SSPC-SP 6 Commercial Blast Cleaning level of steel preparation.

C. Shop Primer
   1. Prime Steel with Polyamide Epoxy; Basis of Design Material – Tnemec Series N69 HI-Build Epoxoline II; Sherwin Williams Macropoxy 646; approved equal.
   2. Primer coat thickness: 2 to 3 mils.
D. Intermediate Coat
   1. Polyamide Epoxy; Basis of Design Material – Tnemec Series N69 HI-Build Epoxoline II; Sherwin Williams Macropoxy 646; approved equal.
   2. Intermediate coat thickness: 3 to 5 mils.

E. Top Coat - Steel Exposed to view only
   1. Polyamide Epoxy; Basis of Design Material – Tnemec 73-Color Endura-Shield; Sherwin Williams Acrolon 218; approved equal.
   2. Intermediate coat thickness: 2 to 3 mils.

2.04 GALVANIZING

A. Steel fabrications: ASTM A123/A123M: Hot-dip process after fabrication – G90 minimum.

B. Bolts, Connectors, and Anchors: ASTM A153/A153M.

C. Washers: ASTM F2329.

2.05 FABRICATION TOLERANCES

A. Squareness: 1/8-inch maximum difference in diagonal measurements.

B. Maximum Offset between Faces: 1/16 inch.

C. Maximum Misalignment of Adjacent Members: 1/16 inch.

D. Maximum Bow: 1/8 inch, 3 in 48 inches.

E. Maximum Deviation from Plane: 1/16 inch in 48 inches.

2.06 MISCELLANEOUS MATERIALS

A. Non-Shrink Grout
   1. Non-shrink, non-corrosive and non-staining pre-packaged commercially produced grout conforming to ASTM CC1107, Grade C.
   2. Minimum Compressive Strength at 28 days: 5,000 psi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field conditions are acceptable and are ready to receive Work.

B. Verify bearing surfaces are at correct elevation.

C. Verify setting assemblies, anchors, or rods are set in correct locations and arrangements with correct exposure for steel attachment.

3.02 PREPARATION

A. Furnish templates or anchor bolt setting assemblies as detailed for installation of anchor rods and embedment’s in concrete and masonry work.
3.03 ERECTION

A. Comply with the AISC Specifications and Code of Standard Practice.

B. Maintain work in a safe and stable condition during erection.

C. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of permanent bracing.

D. Connections
   1. General: Form connections to provide a uniformly true assembly forming right angles between intersecting members.
   2. Bolted Connections: Field connect members with threaded fasteners; torque to required resistance; tighten to snug tight for bearing type connections.
   3. Welded Connections: Field welds shall conform to requirements of AWS D1.1 and be performed by an AWS certified welder. Fit welded components with the faying surfaces properly mated to be free of obstructions and gaps.

E. Do not field cut or alter structural members without approval of Engineer.

F. After erection, touch up welds and abrasions to match shop finish.

3.04 GROUT INSTALLATION

A. Grout providing full coverage under all base plates requiring any elevation adjustment or shimming.

B. Fill void under bearing surface completely with grout. Install and pack grout to remove air pockets.

C. Moist cure grout surrounding it with saturated curing fabric.

D. Remove forms after grout is set. Trim grout edges to from smooth surface, splayed 45 degrees.

E. Tighten anchor bolts after grout has cured for a minimum of 3 days.

3.05 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 1/4 inch.

B. Maximum Offset from Alignment: 1/4 inch.

** END OF SECTION **
SECTION 05 31 00
STEEL DECKING

PART 1 GENERAL

1.01 SUMMARY OF WORK
   A. This Section covers steel roof deck and interior steel deck.

1.02 RELATED SECTIONS
   A. Section 05 12 00 – Structural Steel Framing.

1.03 REFERENCES
   A. Codes/Standards – The work and materials of this Section shall comply with:
      2. D1.1 "Structural Welding Code – Steel" and D1.3 "Structural Welding Code – Sheet Steel."
   B. ASTM A653, "Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process".
   D. ASTM A1008 - Steel, Sheet, Cold Rolled, Carbon, Structural, High Strength Low Alloy, High Strength Low Alloy with Improved Formability, Solution Hardened, and Baked Hardenable.
   F. ASTM AC1513 – Standard Specifications for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
   G. Steel Deck Institute (SDI) – ANSI/SDI standard RD1.0 "Standard for Steel Roof Deck".

1.04 SUBMITTALS
   A. Product Data: For each type of deck, accessory, and product indicated.
   B. Product Certificates: Signed by steel deck manufacturers certifying that products furnished comply with requirements.
   C. Welding Certificates: Copies of certificates for welding procedures and personnel.
   D. Product Test Reports: From a qualified testing agency indicating that each of the following complies with requirements, based on comprehensive testing of current products:
      1. Mechanical fasteners.
   E. Shop Drawings:
      1. Show layout and types of deck panels, anchorage details.
      2. Show reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.
1.05 **DELIVERY, STORAGE, AND HANDLING**

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage.

C. Protect with a waterproof covering and ventilate to avoid condensation.

1.06 **MEASUREMENT AND PAYMENT**

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

**PART 2 PRODUCTS**

2.01 **MANUFACTURERS**

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Steel Deck Acceptable Manufacturers:
   1. Vulcraft by Nucor Corp.
   2. Marlyn Steel Products, Inc.
   3. Roof Deck, Inc.
   4. United Steel Deck by Canam Steel Corp.
   5. Verco Manufacturing Co.

2.02 **ROOF DECK**

A. Steel Roof Deck:
   2. Steel Sheet: ASTM A653 or A1063 steel, G60 galvanizing.
   3. Deck Profile: 1-1/2 -inch Type B – 6-inch corrugation spacing with 2-1/2 -inch bearing flute width with nested side laps.
   4. Design Uncoated-Steel Thickness: 0.0358 inches (20 gage)
   5. Span Condition: Minimum 2-span condition
   6. Side Laps: Overlapped

B. Roof Deck Fasteners:
   1. Self-drilling Metal Screws-Hex Head: Compliant with ASTM C1513.
   2. Primary Fasteners: #12x7/8 inch – Side Lap Fasteners: #10x1/2 inch.
   3. Acceptable Fasteners:
      b. HILTI: ICC-ES_ESR 2196
      c. SIMPSON: ICC-ES_ESR 3006

2.03 **CEILING DECK**

A. Ceiling Deck:
   2. Steel Sheet: ASTM A653 or A1063 steel, G60 galvanizing.
   3. Deck Profile:
      a. Spans less than 9 feet (Generator and Electrical Rooms): 1-1/2 -inch Type B – 6-inch corrugation spacing with 2-1/2 inch bearing flute width with nested side laps.
      b. Spans exceeding 9 feet (Pump Room): 3-inch Type N – 8-inch corrugation spacing with 2-5/8 -inch down flute width with nested side laps.
4. Design Uncoated-Steel Thickness: 0.0358 inches (20 gauge)
5. Span Condition: Minimum 1-span condition
6. Side Laps: Overlapped

B. Ceiling Fasteners:
1. Self-drilling Metal Screws- Hex Head: Compliant with ASTM C1513
2. Primary Fasteners: #12 with ANSI B18.21.1 Washers galvanized per ASTM A153 for 3-inch deck
   #10 for 1-1/2 inch deck Length = 7/8 inch typical; 3 inch where ceilings have fire assembly
   Side Lap Fasteners: Side Lap Fasteners: #6 x 1/2-inch flat head - #8 x 1 inch along edge angles
3. Acceptable Fasteners:
   b. HILTI: ICC-ES_ESR 2196
   c. SIMPSON: ICC-ES_ESR 3006

2.04 FABRICATION

A. Manufacture deck units to lengths as indicated on Shop Drawings.
   1. Panel end conditions are to be end-lapped, 2 inch minimum.
   2. Side laps to be nested for self-drilling screw attachment.

B. Fabricate steel deck accessories from the same gauge and materials as adjacent steel deck.

2.05 ACCESSORIES

A. Valley Flashing and Miscellaneous Sheet Metal Deck Accessories:
   1. Steel Sheet: ASTM A653 or A1063 steel, G60 galvanizing.
   2. Design Uncoated-Steel Thickness: 0.0358 inches (20 gauge).

B. Galvanizing Repair Paint: Zinc-rich primer compliant with SSPC-Paint 20.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field conditions are acceptable and are ready to receive Work.

B. Examine supporting frame and field conditions for compliance with requirements for installation
tolerances and other conditions affecting performance.

3.02 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary ANSI/SDI
   standard RD1.0 "Standard for Steel Roof Deck", manufacturer's written instructions, and
   requirements in this Section.

B. Locate decking bundles to prevent overloading of supporting members.

C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and
   bearing on supporting frame before being permanently fastened. Do not distort side laps.

D. Place deck panels flat and squarely positioned and securely fastened to supporting frame without
   warps or deflection.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or
   adjacent to decking. Overlaps exposed to view shall be factory edge.

F. Locate and install self-drilling screws according to deck manufacturer's written instructions.
3.03 INSTALLATION, ROOF DECK

A. Fasten roof deck panels to steel supporting members with self-drilling hex head screws.

B. Deck Fastening: Place screws in each bearing flute using a 36/7 pattern: 6 inches on center.

C. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports with a minimum of 3 screws per deck span.

D. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches.

E. End Joints: Lapped 2 inches minimum.

F. Miscellaneous Roof Deck Accessories:
   1. Finish all valleys with a valley flashing sheet extending the entire length.
   2. Terminate ridges with vented assemblies.
   3. Close eave ends with a continuous brake metal backer for attachment of gutter and finishes.

3.04 INSTALLATION, CEILING DECK

A. Fasten roof deck panels to steel supporting members with self-drilling hex head screws supplemented with standard washers.

B. Deck Fastening:
   1. 1-1/2 -inch Deck: Place screws in each bearing flute using a 36/7 pattern: 6 inches on center.
   2. 3-inch Deck: Place screws in each bearing flute using a 24/4 pattern: 8 inches on center.

C. Side-Lap and Perimeter Edge Fastening:
   1. 1-1/2 -inch Deck: Fasten side laps and perimeter edges of panels between supports with a minimum of 3 screws per deck span. Direct screw points upward away from occupied space.
   2. 3-inch Deck: Fasten side laps and perimeter edges of panels between supports with a minimum of 12 inches on center. Direct screw points upward away from occupied space.

D. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches.

E. End Joints: Lapped 2 inches minimum.

3.05 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780 and manufacturer’s written instructions.

B. Construction loads must not exceed carrying capacity of deck.

** END OF SECTION **
SECTION 05 40 00
COLD-FORMED METAL FRAMING

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. This Section covers:
1. Metal Studs and Track Assemblies.
2. Z-Furring.
3. Furring Hat Channel.

1.02  RELATED SECTIONS

A. Section 05 31 00 – Steel Deck.

1.03  REFERENCES

A. AISI S100 NASPEC (North American Specification) for the Design of Cold-Formed Steel Structural Members.

B. AISI S200, "North American Standard for Cold-Formed Steel Framing - General Provisions."

C. AISI S201, "North American Standard for Cold-Formed Steel Framing - Product Standard."

D. AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing."

E. AISI S240, "North American Standard for Cold-Formed Steel Structural Framing."


G. ASTM A653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.


I. ASTM A1003/A 1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.

J. ASTM C955 - Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.


L. American Iron and Steel Institute Publication S100-07 “Specification for the Design of Cold-Formed Steel Structural Members”.

M. ASTM C1513 Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.


O. Steel Stud Manufacturers Association (SSMA).
1.04 SUBMITTALS
A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
B. Shop Drawings:
   1. Provide shop drawings showing plans, sections, assemblies, and finish material attachment.
      Include layout, spacing, sizes, thicknesses, and types of cold-formed steel framing; fabrication;
      and fastening and anchorage details, including mechanical fasteners.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Store products in manufacturer's unopened packaging with identification labels intact until ready for
   installation.
B. Protect and store materials protected from exposure to rain, snow or other harmful weather
   conditions.
C. Protect and store cold-formed steel framing from corrosion, moisture staining, deformation, and other
   damage during delivery, storage, and handling as required in AISI S202, "Code of Standard Practice
   for Cold-Formed Steel Structural Framing."

1.06 MEASUREMENT AND PAYMENT
A. Include all material, equipment, labor, and associated work necessary to complete the work described
   in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 COLD FORMED METAL SECTIONS
A. General
   1. Cold-Formed Steel Framing Standards: Conformance with NASPEC for the Design of Cold-
      Formed Steel Structural Members, ANSI S200, and ASTM C955.
   2. Materials
      a. Sheet steel conforming to ASTM A1003, Type H and ASTM A653, ASTM A875, or
         ASTM C955.
      b. Minimum yield strength 33 ksi.
      c. Minimum protective G-60 galvanized coating.
B. Stud/joists and Runner Track
   1. Studs - standard C-shaped steel sections with stiffened flanges
      a. Soffit Framing
         (1) Cold-formed galvanized steel studs, unpunched – SSMA 250S162-33.
         (2) Web Depth 2-1/2 inches - Flange Width: 1-5/8 inches - Design Thickness: 0.0346 inch.
      b. Fire Barrier Framing
         (1) Cold-formed galvanized steel studs, unpunched – SSMA 600S162-33.
         (2) Web Depth 6 inches - Flange Width: 1-5/8 inches - Design Thickness: 0.0346 inch.
   2. Runner Track
      a. Soffit Framing
         (1) Cold-formed galvanized steel runner track, unpunched – SSMA 250T125-33.
         (2) Web Depth 2-1/2 inches - Flange Width: 1-1/4 inches - Design Thickness: 0.0346 inch.
      b. Fire Barrier Framing
         (1) Cold-formed galvanized steel studs, unpunched – SSMA 600T125-33.
         (2) Web Depth 6 inches - Flange Width: 1-5/8 inches - Design Thickness: 0.0346 inch.
C. Z-Furring: For attachment of steel siding to masonry walls.
   1. Web Depth 3-1/2 inches - Flange Widths: 1-1/4 inches - Design Thickness: 0.05 inch.

D. Furring Hat Channels: For attachment of wooden roof sheathing to steel deck.

E. Resilient Channels for Fire Barrier Assembly
   1. Channel Depth 1/2 inch - Top Flange Width: 1-1/2 inches - Design Thickness: 0.0232 inch.

2.02 FASTENERS

A. Cold-Formed Metal Component Connections
   1. Self-drilling metal screws compliant with ASTM C1513 manufactured to ASME B18.6.3& SAE J78 dimensions.
      a. Corrosion-resistant coating for interior and protected applications.
      b. Type 410 stainless steel for cold formed soffit framing.
      d. Size: Connection Hat Channels #8-18 x 1/2 inch minimum - #6 x 1/2-inch minimum Soffit Framing.
      e. Resilient Channel Assemblies: #8-18 x 1-1/2 inch.

B. Cold-Formed Z-Furring and Soffit Track attachment to Concrete Masonry
   1. Stainless Concrete Screws:1/4 inch by 1-1/4 inch Type 410 concrete screws.
   2. Stainless Steel Washer: ASTM A240, Type 304.
   3. Basis of Design: Tapcon by ITW or approved equal.

2.03 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780 or SSPC-Paint 20.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field conditions are acceptable and are ready to receive Work.

B. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrate surfaces to receive attachment of cold formed steel framing to be free of moisture, dirt, debris, or other deleterious materials.

3.03 INSTALLATION

A. General
   1. Install cold-formed steel framing in accordance with ASTM C1007 and AISI S200.
   2. Install cold-formed steel framing and accessories plumb, square, and true, with connections securely fastened.
   3. Cut framing members by sawing or shearing; do not cut using heat.
   4. Fasten cold-formed steel framing members with screws installed in accordance with the Drawings, and comply with requirements for size, spacing, edge distances, and screw penetration.
5. Install framing members in single continuous lengths unless splice connections are indicated.
6. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

B. Soffit Framing
   1. Place soffit framing horizontally level in a uniform plane attached at right angles to the building face and facia.
   2. Concrete screws used to mount runner track shall be provided with stainless steel washers placed between the screw head and track.
   3. Mount runner track to masonry fastening in concrete masonry at intervals of no less than 12 inches on center alternating side of the track.
   4. Space soffit support framing stud/joists at 24 inches on center maximum.
   5. Fasten studs/joists to runner track and facia backer with self-drilling screws.

C. Cold-Formed Z-furring
   1. Mount Z-furring uniformly plumb at intervals suitable to fit polystyrene insulation panels snug tight to webs of Z-furring with a maximum nominal spacing of 24 inches on center.
   2. Fasten Z-furring to concrete masonry with concrete screws at intervals of no less than 12 inches on center and 4 inches from member ends.
   3. Terminate Z-furring 4 to 8 inches above wall base.

D. Furring Hat Channels
   1. Mount Furring Hat Channels uniformly at right angles to the corrugations in metal deck.
   2. Position furring hat channels to uniformly coincide with panel edges for roof sheathing.
   3. Fasten furring hat channels 12 inches on center, staggering locations on each side.

E. Resilient Channels
   1. Mount Resilient Channels uniformly at right angles to attached framing and along the perimeter of all attached sheathing.
   2. Space channels at 24 inches on center maximum.
   3. Fasten to framing with #8 self-drilling screws at intersections with each framing member.

** END OF SECTION **
SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY OF WORK
A. This Section covers all items fabricated from metal shapes, plates, or bars.
B. Fabricated metal items and pipe supports, which are indicated on the Drawings, but not mentioned specifically herein, shall be fabricated in accordance with the applicable requirements of this Section.

1.02 RELATED SECTIONS
A. Section 03 30 00 – Cast-in-Place Concrete.

1.03 REFERENCES
K. American Society for Testing and Materials (ASTM) A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process


R. American Welding Society (AWS) A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.


1.04 SUBMITTALS

A. Shop Drawings:
   1. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
   2. Include erection drawings, elevations, and details where applicable.
   3. Indicate welded connections using standard AWS A2.4 welding symbols.
   4. Indicate net weld lengths.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Accept metal fabrications on site in labeled shipments. Inspect for damage.

B. Protect metal fabrications from damage by exposure to weather.

1.06 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

A. Steel Plate and Angles: ASTM A36/A36M.

B. Hollow Structural Sections: ASTM A500, Grade B.

C. Steel Pipe: ASTM A53/A53M, Grade B.

D. Sheet Steel: ASTM A653/A653M, Grade 33 Structural Quality with galvanized coating.

E. Bolts: ASTM A325; Type 1.
   1. Finish: Hot-dipped galvanized.

F. Nuts: ASTM A563 heavy hex type.
   1. Finish: Hot-dipped galvanized.
G. Washers: ASTM F436; Type 1.
   1. Finish: Hot-dipped galvanized.

H. Welding Materials: AWS D1.1; type required for materials being welded.

I. Anchor Bolts – Adhesive Anchors
   1. Epoxy adhesive compliant with ASTM C881, Type I to IV, Grade 3, Class B or C or manufacturer’s equal proprietary adhesive.
   4. Washers – Carbon Steel ANSI B18.22A Type A galvanized per ASTM A153; Stainless Steel ASTM A240, Type 304.

2.02 STEEL FABRICATIONS

A. Fit and shop assemble items in largest practical sections for delivery to site. Fit at site without field damage to the shop-applied coating system.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by intermittent welds and plastic filler or continuous welds as indicated on Drawings.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts, unobtrusively located, consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

G. Fabricate concrete-embedded weldments to be interconnected with rods in pairs to assist in placing the embedded weldments plumb and level and to ensure the embedded weldments are properly mated to the guard rails that will be mounted to them.

2.03 SHOP APPLIED FINISHES – STEEL

A. Preparation and finish painting of steel fabrications to be done completely in the shop and touched up in the field.

B. Clean surfaces free of rust, scale, grease, and foreign matter to a level compliant with SSPC-SP 6 Commercial Blast Cleaning level of steel preparation.

C. Shop Primer
   1. Refer to Section 09 90 00 Painting for shop primer specifications.
   2. Prime Steel with Polyamide Epoxy; Basis of Design Material – Tnemec Series N69 HI-Build Epoxoline II; approved equal.
   3. Primer coat thickness: 2 to 3 DFT.

2.04 FABRICATION TOLERANCES

A. Squareness: 1/8-inch maximum difference in diagonal measurements.

B. Maximum Offset between Faces: 1/16 inch.
C. Maximum Misalignment of Adjacent Members: 1/16 inch.

D. Maximum Bow: 1/8 inch 3 in 48 inches.

E. Maximum Deviation from Plane: 1/16 inch in 48 inches.

2.05 MISCELLANEOUS MATERIALS

A. Non-Shrink Grout
   1. Non-shrink, non-corrosive and non-staining pre-packaged commercially produced grout conforming to ASTM C1107, Grade C.
   2. Minimum Compressive Strength at 28 days: 5,000 psi.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field conditions are acceptable and are ready to receive Work.

3.02 PREPARATION

A. Supply steel items required to be cast into concrete with setting templates to appropriate sections.

B. Thoroughly clean concrete-embedded steel weldments with an SSPC-SP1 Solvent Cleaning preparation to remove all oil and contaminants prior to being placed within concrete.

C. Prepare fabrications receiving a painted finish as required by the paint system.

3.03 INSTALLATION

A. Install items vertically plumb and horizontally level, accurately fitted, free from distortion or defects.

B. Placement of Non-Shrink Grout
   1. Clean and roughen concrete surfaces under base plate locations.
   2. Wash cleaned surfaces allowing concrete to remain saturated-surface-dry.
   3. Apply properly batched non-shrink grout over entire base plate footprint.
   4. Set support fabrications at required elevation, orienting it vertically plumb and horizontally level, fully embedding steel shims if required to maintain proper elevation.
   5. Finish outer surface of grout with uniformly squared edges.

C. Install anchor bolts in accordance with manufacturer recommendations after non-shrink grout has set up.

D. Make provisions for erection stresses. Install temporary bracing to maintain alignment until permanent bracing and attachments are installed.

E. Field weld components indicated on Drawings and Shop Drawings.

F. Perform field welding in accordance with AWS D1.1.

G. Obtain approval of Engineer prior to site cutting or making adjustments not scheduled.

H. After erection, touch up abrasions or damaged finishes with painting system specified above, including proper preparation of surface and application of 3-coat painting system.
3.04 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 1/16 inch.
B. Maximum Offset from Alignment: 1/32 inch.

** END OF SECTION **
SECTION 06 16 00
SHEATHING

PART 1  GENERAL

1.01  SUMMARY OF WORK
A. This Section covers plywood sheathing utilized for roof decking under roofing shingle systems.

1.02  RELATED SECTIONS
A. Section 05 31 00 – Steel Decking.
B. Section 05 40 00 – Cold-Formed Metal Framing.
C. Section 07 30 00 – Steep Slope Roofing.

1.03  REFERENCES
A. American Plywood Association (APA).
B. American Society for Testing and Materials (ASTM) C954 – Standard Specifications for Steel Drill Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch to 0.112 inch Thickness.
C. National Forest Products Association (NFPA).

1.04  SUBMITTALS
A. Submit product data including manufacturer, APA rating information, span ratings, and ply composition.

1.05  DELIVERY, STORAGE, AND HANDLING
A. Ship sheathing materials to site in protected bundles to maintain integrity of panels.
B. Protect sheathing from damage by exposure to weather.

1.06  MEASUREMENT AND PAYMENT
A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2  PRODUCTS

2.01  MATERIALS - STEEL
A. Sheathing
   1. Plywood Roof Sheathing: APA Rated Sheathing; Exposure 1; Span Rating 40/20.
   2. Thickness: 3/4 inch.

B. Fasteners
   1. Self-drilling wood attachment screws for metal support compliant with ASTM C954.
   2. Flush finish heads countersink, bugle, or wafer heads.
   3. Size: #10-16 x 1-1/4 inch minimum for attachment to hat channel furring engaging 3 threads past back side of furring channel.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify field conditions are acceptable and are ready to receive placement of sheathing.
B. Verify positioning of furring hat channels are installed to coincide with sheathing panel edges.

3.02 PREPARATION
A. Plan layout of sheathing sheets ensuring panel sheets sections have maximum dimensions in each direction.
B. Place stacks of unused sheathing off the furring hat channels to avoid overloading channels.
C. Square the orientation of sheathing panels with the steel roof deck to provide a uniformly course layout with panel edges running parallel to the roof edge.

3.03 INSTALLATION
A. Square plywood panels with the steel deck, aligning them parallel with roof deck corrugations.
B. Place roof sheathing oriented perpendicular to furring hat channels, staggering ends to interlock panels. Offset panel ends a minimum of two feet with typical offset dimension of one-half panel dimension.
C. Fasten sheathing panels with specified wood with metal screws at 6 inches on center along panel edges and 12 inches on center in the sheathing panel fields.
D. Install screws penetrating through the steel deck plus three threads. If shorter specified screws are used, placement of screws shall be made to land in upper flutes of the steel deck only. Longer screws must be used for passage through steel deck with down flutes.
E. Set screws flush with top of sheathing without depressing them below the surface. Do not over drive screws to collapse hat channels.

** END OF SECTION **
SECTION 07 21 00
BUILDING INSULATION

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Section includes rigid and semi-rigid board insulation at cavity wall construction and perimeter foundation walls.

B. Section also includes batt insulation and vapor retarder in ceiling construction.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 03 30 00 – Cast-in-Place Concrete.

C. Section 04 20 00 – Unit Masonry.

D. Section 05 31 00 – Steel Decking.

1.03 REFERENCES

A. ASTM International:

1.04 SUBMITTALS

A. Submit in accordance with Section 01 00 00.

B. Product Data: Submit data on product characteristics, performance criteria, limitations, and adhesives.

C. Manufacturer's Installation Instructions: Submit special environmental conditions required for installation, installation techniques, and repair methods.

D. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 RIGID BOARD INSULATION

A. Cavity Wall Insulation: ASTM C578 Extruded Polystyrene Insulation, Type IV, cellular type conforming to the following:
   1. Board Thickness: 3-inch or as indicated on the Drawings.
   2. Thermal Resistance: 5-year aged R-value, per inch, of 5.4 and 5.0 minimum at 40 degrees F and 75 degrees F, respectively.
   3. Water Absorption: In accordance with ASTM C272, 0.1 percent by volume maximum.

B. Manufacturers:
   1. Dow Chemical: Styrofoam Square Edge.
   2. Owens Corning: Foamular 250, XPS.
   3. Certainteed: Certifoam 25 SE.
   4. or approved equal.

2.02 BLANKET INSULATION

A. Batt Insulation: ASTM C665 Fiberglass, Type 1, conforming to the following:
   1. Thickness: 6-inch nominal or as indicated on the Contract Drawings.
   2. Thermal Resistance: R of 19 at 75-degrees F, or as indicated on the Drawings.
   3. Linear Shrinkage: 1 percent or less.
   4. Water Absorption: 0.05 percent by volume maximum.

B. Manufacturers:
   1. Owens Corning: EcoTouch Unfaced.
   2. Certainteed: CertaPro AcoustaTherm Batt Unfaced.
   4. or approved equal.

2.03 ADHESIVES

A. Adhesive: Type recommended by insulation manufacturer for application.

2.04 ACCESSORIES

A. Foam sealant: Polyurethane insulating foam sealant; one-component, gun or straw applied; UL classified; containing no solvents, CFC’s or VOC’s; moisture-resistant.
   1. Insulation Fasteners: Galvanized steel, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place. Use insulation fasteners with large washer plates.

B. Tape: Self-adhering type as recommended by manufacturer.
PART 3 EXECUTION

3.01 EXAMINATION

A. Verify substrate, adjacent materials, and insulation boards are dry and ready to receive insulation and adhesive.

B. Verify substrate is flat, free of honeycomb, fins, irregularities, materials or substances that may affect adhesive bond.

3.02 INSTALLATION OF BOARD INSULATION

A. Install all insulation products in accordance with insulation manufacturer’s instructions. Adhesives used with foam insulation shall be approved for use by insulation manufacturer and designated for use bonding to both insulation and concrete unit masonry.

B. Cavity Walls
   1. Adhere insulation in three continuous beads per board length.
   2. Install boards vertically between Z-furring channels.
   3. Place boards in method to maximize contact beddings. Stagger joints. Butt edges and ends tight to adjacent board and to protrusions.
   4. Cut and fit insulation tight to protrusions or interruptions to insulation plane.
   5. Install insulating foam at insulation joints and around penetrations through insulation. Once foam has set up, cut foam back to plane of insulation, so that it does not protrude beyond face of insulation.

3.03 INSTALLATION OF BLANKET INSULATION

A. Install insulation products in accordance with insulation manufacturer’s instructions.

B. Install as shown on Drawings without gaps or voids.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tight in spaces and tight to exterior side of mechanical and electrical services within plane of insulation.

** END OF SECTION **
SECTION 07 30 00
STEEP SLOPE ROOFING

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. This Section covers shingles units, underlayment, valley protection, ridge, eave, roof vents, roofing rainware (gutters and downspout) along with metal flashings and accessories.

1.02  RELATED SECTIONS

A. Section 05 40 00 – Cold-Formed Framing.
B. Section 06 16 00 – Sheathing.
C. Section 07 46 19 – Steel Siding.
D. Section 07 92 00 – Joint Sealants.

1.03  REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM C954 – Standard Specifications for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. to 0.112 in. Thickness.
   4. ASTM C1513 – Standard Specifications for Steel tapping Screws for Cold-Formed Steel Framing Connections.
   8. ASTM D1970 – Standard Specifications for Steel tapping Screws for Cold-Formed Steel Framing Connections.

B. American Society of Mechanical Engineers (ASME)
   1. ASME B16.6 – Slotted and Recessed Head Screws.
   2. ASME B18.1 – Small Solid Rivets.
1.04 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Steel Roofing materials, flashings, fasteners and accessories.
   3. Dimensions, physical properties, and typical details.
   4. Storage and handling requirements and recommendations.
   5. Installation methods.

B. Shop Drawings:
   1. Show layout, methods of attachment, jointing, provisions for movement, flashing, trim, edge and field conditions, interface with adjacent materials, locations of cutouts or special shapes, existing construction, and details.
   2. Submit overall layout details, edge conditions, joints, fastener and sealant placement, flashings, penetrations, and special conditions.
   3. Identify factory- and field-assembled work.

C. Samples
   1. One complete set of color chips representing manufacturer's full range of available colors and patterns.
   2. Shingle Unit: One full panel section.
   3. Fasteners and Accessories: two of each type, full size; indicate use of each.

D. Verification Samples
   1. One sample of each actual finish product provided representing product, color, and texture patterns.

E. Installer qualifications.

F. Closeout submittals
   1. Maintenance and cleaning instructions.
   2. Warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacture shall have a proven history of producing steel siding product with a suitable track record of performance.

B. Installer Qualifications: Installer shall have a proven history of installing steel roof products with a suitable track record of successful installations.

C. Mock-Up
   1. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   2. Do not proceed with remaining work until mockup is approved by Owner.
   3. Refinish mock-up area as required to produce an accepted mockup configuration.
   4. Accepted mock-up may be included in the completed work and will establish the standard of acceptance for workmanship and aesthetics for remaining work.
1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

B. Delivery Receipt
   1. Organize package contents to minimize sorting on site.
   2. Verify quantities and condition immediately upon receipt.
   3. Remove damaged products from site and coordinate with manufacturer to replace with new materials to meet specified requirements.

C. Storage of Products
   1. Store off the ground, within manufacturer's temperature and environmental limits, away from moisture, protected from traffic and construction activities.
   2. Minimize on-site storage prior to installation.
   3. Prevent contact with materials capable of causing discoloration or staining.

D. Handling: Handle materials to avoid damage.

1.07 SITE CONDITIONS

A. Ensure that products of this Section are supplied to affected trades in time to prevent interruption of construction progress.

B. Field Measurement: Verify field conditions prior to shop drawings or fabrications.

C. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

A. Manufacturer Warranty
   1. Transferable by the original property owner to the next owner of the property with proper notification to manufacturer. Provide original warranty registration for Owner including the certificate registration number and date the siding was installed.
   2. Warranty Duration: 50 years structured as follows:
      a. Ten (10) year full warranty including materials and labor cost to correct deficiencies.
      b. During year 11, the manufacturer shall provide 50 percent of materials and labor cost to correct deficiencies.
      c. Owner shall pay 5 percent of labor and materials cost to correct deficiencies for each full year following the 11-year initial warranty.
      d. After twenty (20) years the manufacturer shall pay 5 percent of labor and materials cost to correct deficiencies throughout the remaining duration of warranty period of fifty (50) years.
   3. Warranty Against Fading: 30 Years.

1.09 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2  PRODUCTS

2.01 METAL ROOF SHINGLE SYSTEM

A. Steel Shingle Panels Material -- ASTM A653 Hot-dip Galvanized Commercial Steel (CS) Intermediate Carbon Content Type B - 28-gauge (0.015-inch base metal) G90 galvanized steel.

B. Base Finish: Aluminum Chromate Conversion - corrosion inhibiting primer. Basis of Design: BONDERITE chromate conversion coating manufactured by Henkel Corporation or equal.

C. Finish Coat: Manufacturer 70 percent polyvinylidene fluoride or polyvinylidene difluoride (PVDF) Permanent Finish – Minimum Thickness: 1 mil.

D. Basis of Design Metal Roof Shingle or Equal:
   2. Panel Size: 50-inch x 12-inch.
   3. Surface Finish: 268 T-Tone HD.

2.02 ROOF ACCESSORIES

A. Eave and Rake Starter Strips – Ridge/Hip Caps – Valley Flashing and Starter – Roof Trims
   3. Finish Coat: Manufacturer 70 percent polyvinylidene fluoride or polyvinylidene difluoride (PVDF) Permanent Finish – Minimum Thickness: 1 mil.
   4. Basis of Design Metal Roof Accessories or Equal:
      b. Color: T-Tone.
   5. Valley Style: Open Valley.

B. Vented Ridge Assembly
   1. Vented Ridge Cap Assembly.

2.03 RAINWARE - GUTTERS AND DOWNSPOUTS

A. Soffit, Fascia, and Trim Material -- ASTM A653 Hot-dip Galvanized Commercial Steel (CS) Intermediate Carbon Content Type B - 28-gauge (0.015-inch base metal) G60 galvanized steel.

B. Base Finish: Aluminum Chromate Conversion - corrosion inhibiting primer. Basis of Design: BONDERITE chromate conversion coating manufactured by Henkel Corporation or equal.

C. Finish Coat: Manufacturer Warranted Permanent Finish – Minimum Thickness: 1 mil.

D. Basis of Design: Steel Gutter System or Equal:
   2. Type: Full Vented Panels.
4. Hanger System:
   a. Sampson Hanger.
   b. #10-16 Self-drilling Type 410 stainless hex head metal screws compliant with ASTM C1513 manufactured to ASME B18.6.3 & SAE J78 dimensions.

E. Basis of Design: Steel Downspout System or Equal
   1. Size: 4-inch by 3-inch Finishes.

2.04 FASTENERS

A. Shingle and Flashing Attachment Clips – 24-gauge ASTM A653 by Manufacturer

B. Fasteners for Shingle Attachment – Ridge/Hip Treatments - Special Assemblies
   1. Use wood screws provided by roofing material manufacturer compliant with ASME B18.1. standards.
      a. Hot-dip galvanized.
      b. Hex Head.
      c. Size: #10 by 1 inch, 1-1/2 inch, or 2 inch minimum size as recommended by the manufacturer.

C. Fasteners for Accessory Attachment – Starter Edge, Valley Flashing and Starter
   1. #10 by 1 inch Truss/Wafer Head wood screws compliant with ASME B18.1. standards.

D. Gutter Attachment Exposed Screws
   1. #10-16 by 1 inch ASTM C954 or ASTM C1513 self-drilling hex head; Type 410 stainless steel.

2.05 UNDERLAYMENT

A. All underlayment materials and accessories shall be provided by the same manufacturer.

B. Underlayment – Water and Ice Protection
   1. Self-Adhering Sheet Membrane Roof Underlayment
      a. Membrane Thickness: 40 mils per ASTM D3767 Method A.
      b. Membrane Tensile Strength: 250 psi per ASTM D412 Die C Modified.
      c. Membrane Elongation: 250 percent per ASTM D412 Die C Modified.
      d. Low Temperature Flexibility: Unaffected at minus 20 degrees F per ASTM D1970.
      e. Adhesion to Plywood: 3.0 pounds per inch width (876 N/m) per ASTM D903.
      f. Maximum Permeance: 0.05 perms (2.9 ng/sqms Pa) per ASTM E96.
      g. Material Weight Installed: 0.3 pounds per square foot per ASTM D461.

C. Primer
   1. Use manufacturer primer if required for adhesion of underlayment membrane.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates for compliance with requirements of the underlayment manufacturer for proper product performance. Proceed only after sheathing is clean and free of deleterious conditions.

B. Examine surface of sheathing to ensure that it is fully anchored in place and free on any unsupported edges, gaps in the sheathing surface, or obstructive projections.
C. Examine the roof surface to ensure it forms true uniform planes suitable for receiving the roofing system.

D. Test adhesion of underlayment to deck surface with a 6-inch square patch in a location where leaving the test patch in place does not obstruct installation. Verify the adhered underlayment membrane is fully bonded to the surface and cannot be dislodged by scuffing or dragging a dimensional lumber board over its surface.

3.02 PREPARATION

A. Clean dirt, debris, or other bond breaking substances on the surface of roof sheathing. Clean away any surface contaminations that may react with or cause damage to underlayment material.

B. Remove or replace any fasteners projecting above sheathing surface plane. Replace fasteners in kind to maintain maximum spacing designated on the Drawings.

C. Remove all splintered edges or delaminated surface veneers. Repair any voids created from removals with resinous wood restoration putty and finish flush with sheathing surface.

D. Trim sheathing edges that are out of true alignment or obstruct creating a true roof edge.

3.03 PROTECTION

A. Metal panel roof shake systems require special protection during construction to prevent damage to panels. Provide protection from damage due to construction operation including placement of tools and equipment and workman foot traffic.

B. Provide protective cover such as anchored foam mats in finished roof areas subjected to repeated traffic.

C. Follow manufacturer recommendations for stepping or kneeling on any roofing components.

3.04 ROOF EAVE STARTER INSTALLATION

A. Place eave edge starter strips around entire eave perimeter fastened directly to sheathing edge. Fasten with specified screws at 12 inches on center and 2 inches from ends, positioned 2 inches in from edge of starter.

B. Overlap ends of starter strip 2 inches to form a splice and fasten through flanges of both strips centered on the splice. Position starter with overlapping surfacing laying uniformly flush against the surface of the underlying strip.

C. Overlap and hem starter strip intersections at corners with a hand brake with no exposed field cut edges. Flatten hems to provide a uniform corner transition.

D. Place vertical face screws at 12 inches on center with gutter installation.

3.05 UNDERLAYERMENT INSTALLATION

A. Verify surface is suitable for adhesion of underlayment with an adhesion patch test. If adhesion is not properly achieved, apply underlayment primer over entire roof surface in accordance with manufacturer instructions.

B. Apply underlayment in fair, dry weather with temperatures of 40 degrees F or higher.
C. Align underlayment uniformly along roof starter holding its outside edge at 1/4 inch from outer starter edge.

D. Cut lengths of membrane 10 to 20 feet to cover roof section.

E. Work starting from center of valleys extending underlayment in each direction.

F. Peel back 1 to 2 feet of release liner and align the membrane properly.

G. Press membrane in place with heavy hand pressure or rollers.

H. Place each successive section of underlayment parallel to lower section overlapping the top of the lower section by 4 inches. End of roll or end of section laps shall be no less than 6 inches.

I. Overlap valley underlayment ends by no less than 12 inches.

3.06 ROOF SYSTEM INSTALLATION

A. Make all cuts for roof installation with a guillotine shear or power saw to provide a uniform cut, or similar equipment to prevent ragged raw edges. Do not use tin snips, aviation shears or other hand-cutting tools that leave ragged edges.

B. Place Rake Starter Strips
   1. Mount rake starter at the top of the underlayment.
   2. Fasten with specified screws at a maximum spacing of 16 inches on center positioned 1 inch in from edge of roof.
   3. Overlap upper starter strip over the strip 2 inches to form a splice and fasten through flanges of both strips centered on the splice. Position starter with overlapping surfacing laying uniformly flush against the surface of the underlying strip.
   4. Overlap and hem starter strip intersections at corners with a hand brake with no exposed field cut edges. Flatten hems to provide a uniform corner transition.

C. Open Valley Flashing Installation
   1. Layout Valley Alignment
      a. Snap a chalk line along centerline of roof valley running full length.
      b. Align center of valley flashing with center chalk line.
   2. Bend-fit the valley flashing to seat securely to deck surface of valley.
   3. Field fabricate the bottom of valley flashing.
      a. Cut to the proper angle, allowing an additional 5/8 inch beyond roof edge.
      b. Using a hand brake, hem bottom edge of valley flashing.
      c. Fit valley flashing to fit uniformly snug to eave starter.
   4. Valley Clips and Starter
      a. Place valley clips along outer edges of each side of valley flashing spaced 16 inches on center.
      b. Crimp cut the lowest set of clips to prevent slippage of valley flashing.
      c. Place valley starter on each side of valley flashing exposing the distance indicated on Drawings.
      d. Place valley starter uniformly parallel with equal distance on both sides.
      e. Fasten valley starter with #10 by 1 inch wood screws at 16 inches on center both sides.
   5. Valley Flashing
      a. Run upper valley flash in true alignment up slope of the valley overlapping a minimum of 4 inches over upper end of lower flash.
      b. Place two (2) beads of high-performance silicone sealant, specified in Section 07 92 00 Joint Sealants, transversely across lap seam of valley flashing.
      c. Terminate top valley flashing at the crown with each section overlapping and forming a miter across the center standing rib as detailed on Drawings. Provide two (2) beads of sealant along all overlapped joints at the valley crown.
D. Shake Panel Placement
1. Place steel shake panels as recommended by the manufacturer in all cases starting from left side and working right.
2. Lay out panel system such that a minimum of 1/4 panel is placed along valleys and rakes.
3. Utilize the manufacturer coursing system to provide a randomized shake pattern as follows:
   a. Start the first (1st) eave courses with full or, nearly full per layout, panel. Place each course carefully positioned for a uniformly level panel line aligned parallel with roof eave.
   b. Start the second (2nd) shake panel courses with a cut panel (1/4 panel) utilizing the manufacturer markings. Adjustments to accommodate valley edge termination and layout considerations will be necessary.
   c. Start the third (3rd) course with a 3/4 panel appropriately adjusted for layout and valleys.
   d. Start the fourth (4th) course with a 1/2 panel appropriately adjusted for layout and valleys.
   e. Repeat the four step starting series successively throughout roofing assembly.
4. Carefully and securely interlock shake panels with placement of each unit such that courses run parallel and level and each panel is squared with its adjacent panels.
5. Attach each panel with five (5) anchor clips evenly spaced across the upper edge of each panel. Provide a minimum of two (2) clips on any partial-cut panel section.
6. Crimp cut the first and last clips in each series of panels to prevent horizontal shifting.
7. Hem all field cuts using a hand brake bent 5/8 inch as recommended by manufacturer. Hem all raw cut edges inward from view.

E. Ridge and Hip Caps – Non-Vented
1. Hips and ridges utilize field brake bent starter base. Bend start base with a 10-foot minimum brake, carefully matching the roof pitch with equally dimensioned sides in parallel orientation. Non-uniformly bent starter base will be rejected for use.
2. Extend all steel shake panels to meet at hips and ridges. Gapped no more than 1/4 inch.
3. Place a 6-inch strip of ice and water shield over the joint between panels. Install with the same lapping techniques specified in the Underlayment section in this Specification.
4. Properly brake bend foam sealed starter base and place it uniformly over the hip or ridge equally positioned on each side. Anchor starter base with #10 by 1-1/2 inch screws spaced at 16 inches on center on each side.
5. Start hip cap at the base with a hip cap section hemmed 5/8 inch with a hand brake wrapped securely to interlock with the eave starter edge. Start ridges with a ridge starter base with 4 clips fastened with #10 by 2 inch screws.
6. Place hip/ridge cap components uniformly spaced up hip/ridge, securely interlocking each successive component. Anchor with manufacturer’s clips on each side of cap and fasten each clip with #10 by 1-1/2 inch screws.
7. Terminate hip/ridge caps with the matched manufacturer-provided cap termination.

F. Ridge Caps – Vented
1. Provide a gap in the roof ridge deck and sheathing of 2 inches. Terminate the gap at 12 inches in from inside face of walls.
2. Extend all steel shake panels to meet flush with edge of vent gap.
3. Lay the specified venting foam system across entire length of ridge.
4. The vented ridge utilizes a field brake bent starter base. Bend start base with a 10-foot minimum brake, carefully matching the roof pitch with equally dimensioned sides in parallel orientation. Non-uniformly bent starter base will be rejected for use.
5. Properly brake bend foam sealed starter base and place it uniformly over the hip or ridge equally positioned on each side. Anchor starter base with #10 by 2 inch screws spaced at 16 inches on center on each side compressing foam and providing 5/8 inch clearance for venting area.
6. Start ridge cap at the edge with a ridge starter base anchored with 4 clips fastened with #10 by 2 inch screws. Place the first cap section hemmed 5/8 inch with a hand brake wrapped securely to interlock with the eave starter edge.
7. Place hip/ridge cap components uniformly spaced up the ridge securely interlocking each successive component. Anchor with manufacturer clips on each side of cap and fasten each clip with #10 by 2 inch screws.
8. Terminate hip/ridge caps with the matched manufacturer-provided cap termination.
3.07 ROOF PENETRATIONS

A. Avoid roof penetrations. Flash and detail any penetrations in accordance with manufacturer recommendations and as detailed on drawings.

** END OF SECTION **
SECTION 07 46 19

STEEL SIDING

PART 1     GENERAL

1.01  SUMMARY OF WORK

A. This Section covers exterior siding for typical walls.

1.02  RELATED SECTIONS

A. Section 05 40 00 - Cold-Formed Metal Framing.

B. Section 04 72 00 – Architectural Cast Stone.

1.03  REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM A 653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM C1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.

B. American Society of Mechanical Engineers Standards (ASME) ASME B18.6.3 - Machine Screws, Tapping Screws, And Metallic Drive Screws.

C. Society of Automotive Engineers (SAE) J78 - Steel Self-Drilling Tapping Screws.

1.04  SUBMITTALS

A. Product Data: Manufacturer’s data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Siding materials, flashings, fasteners and accessories.
   3. Dimensions, physical properties, and typical details.
   4. Storage and handling requirements and recommendations.
   5. Installation methods.

B. Shop Drawings:
   1. Show layout, methods of attachment, provisions for movement, flashing, trim, edge and field conditions, interface with adjacent materials, locations of cutouts or special shapes, existing construction, and details.
   2. Submit overall layout details, edge conditions, joints, fastener and sealant placement, flashings, penetrations, and special conditions.
   3. Identify factory- and field- assembled work.

C. Samples
   1. One complete set of color chips representing manufacturer’s full range of available colors and patterns.
   2. Siding: One of each type, full panel width by 12 inches long.
   3. Fasteners and Accessories: Two of each type, full size; indicate use of each.
D. Verification Samples
   1. Two samples of each actual finished product provided, minimum size 6 inches square representing product, color, and texture patterns.

E. Installer qualifications.

F. Closeout submittals
   1. Maintenance and cleaning instructions.
   2. Warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacture shall have a proven history of producing steel siding product with a suitable track record of performance.

B. Installer Qualifications: Installer shall have a proven history of installing steel siding product with a suitable track record of successful installations.

C. Mock-Up
   1. Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   2. Do not proceed with remaining work until mockup is approved by Owner.
   3. Refinish mock-up area as required to produce an accepted mockup configuration.
   4. Accepted mock-up may be included in the completed work and will establish the standard of acceptance for workmanship and aesthetics for remaining work.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturer's unopened packaging bearing the brand name and manufacturer's identification until ready for installation.

B. Delivery Receipt
   1. Organize package contents to minimize sorting on site.
   2. Verify quantities and condition immediately upon receipt.
   3. Remove damaged products from the site and coordinate with the manufacturer to replace with new materials to meet specified requirements.

C. Storage of Products
   1. Store products off the ground, within manufacturer's temperature and environmental limits, away from moisture, protected from traffic and construction activities.
   2. Minimize on-site storage prior to installation.
   3. Prevent contact with materials capable of causing discoloration or staining.

D. Handling: Handle materials to avoid damage.

1.07 SITE CONDITIONS

A. Ensure that products of this Section are supplied to affected trades in time to prevent interruption of construction progress.

B. Field Measurement: Verify field conditions prior to shop drawings or fabrications.

C. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
1.08 **WARRANTY**

A. Manufacturer Warranty
   1. Transferable by the original property owner to the next owner of the property with proper notification to the manufacturer. Provide original warranty registration for the Owner including the certificate registration number and the date the siding was installed.
   2. Warranty Duration: 50 years structured as follows:
      a. Five (5) year full warranty including materials and labor cost to correct deficiencies.
      b. Owner shall pay 10 percent of labor and materials cost to correct deficiencies for each full year following the 5 year initial warranty.
      c. After fourteen (14) years the manufacturer shall pay 10 percent of labor and materials cost to correct deficiencies throughout the remaining duration of warranty period of fifty (50) years.
   3. Warranty Against Fading: 35 Years.

1.09 **MEASUREMENT AND PAYMENT**

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 **PRODUCTS**

2.01 **STEEL SIDING AND SIDING TRIM (CORNERS, J-TRIM, UNDER SILL EDGE)**

A. Steel Siding Material -- ASTM A653 Hot-dip Galvanized Commercial Steel (CS) Intermediate Carbon Content Type B - 28-gauge (0.015-inch base metal) G60 galvanized steel.

B. Base Finish: Aluminum Chromate Conversion - corrosion inhibiting primer. Basis of Design: BONDERITE chromate conversion coating manufactured by Henkel Corporation or equal.

C. Finish Coat: Manufacturer Warranted Permanent Finish – Minimum Thickness: 1 mil.

D. Basis of Design Siding or Equal:
   2. Siding Profile: 6-inch Lap Siding Profile.

2.02 **SOFFIT, FASCIA, AND TRIM (SOFFIT J-CHANNELS, BRAKE METAL FABRICATIONS) MATERIALS**

A. Soffit, Fascia, and Trim Material -- ASTM A653 Hot-dip Galvanized Commercial Steel (CS) Intermediate Carbon Content Type B - 28-gauge (0.015-inch base metal) G60 galvanized steel.

B. Base Finish: Aluminum Chromate Conversion - corrosion inhibiting primer. Basis of Design: BONDERITE chromate conversion coating manufactured by Henkel Corporation or equal.

C. Finish Coat: Manufacturer Warranted Permanent Finish – Minimum Thickness: 1 mil.

D. Basis of Design Soffit System or Equal:
   2. Type: Full Vented Panels.

E. Basis of Design Fascia and Trim Metal or Equal
   2. Color: 792 Willow.
2.03 FASTENERS

A. Fasteners for Siding, Fascia, and Trim Installation and Connections
   1. Self-drilling metal screws compliant with ASTM C1513 manufactured to ASME B18.6.3 & SAE J78 dimensions.
      a. Type 410 stainless steel for cold-formed soffit framing.
      b. Lath/Wafer Head
      c. Size: #6 x 1/2-inch minimum size or larger if recommended by manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify Z-furring is installed at proper intervals and firmly secured and ready for the installation of siding. Verify 24 inches maximum spacing on Z-furring is acceptable to the siding manufacturer for proper attachment and backing of steel siding profiles. If Z-furring requires a closer spacing, notify the general contractor of the required spacing prior to installation of Z-furring.

B. Examine substrates, with installer present, for tolerances and conditions that could adversely affect installation.

C. Do not begin installation until substrates have been properly prepared. Verify dimensions and acceptability of substrate.

D. Verify extruded polystyrene insulation weather barrier installation is complete and properly adhered to the backup masonry wall.

E. Notify the Owner of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Perform all exposed siding cuts with a guillotine cutter or power saw to provide a uniform edge. Do not use tin snips unless the resulting edge is fully concealed in the finished installation.

C. Install siding panels to eliminate end laps to the greatest extent possible terminating at doors and windows. Siding end laps will not be acceptable wherever corner, door, window, or louver openings are available to receive siding panel end terminations.

D. Laps in siding panels, if required, shall be indiscernible in appearance laying flatly with a uniform profile overlapped 3/4 to 1 inch. Lapped joints shall be staggered 48 inches typical with a minimum stagger of 24 inches.

E. Install siding starter strip at the base of the siding and above all wall openings allowing a uniform margin of 1/8 to 3/16 inch above the cast stone sill or trim.

F. Firmly secure all siding components to backing materials.

G. Layout siding panels with all vertical joints lying on a Z-furring strip.

H. Attach siding to Z-furring at each intersection with self-drilling screws firmly securing the siding panel to the furring flange, allowing a gap recommended by the manufacturer, 1/32 inch typical.
I. Install siding with uniform and true lap profiles oriented horizontally level with assemblies of siding oriented vertically plumb. Siding placement shall be free from warps, distortions, or irregular patterns.

J. Corners: Finish with manufacturer standard snap-on outside corner termination and cover assembly placed vertically plumb and at true right angles to the siding panel orientation.

K. Top Edges: Terminate top edges of siding with the manufacturer under sill trim. Gable ends receive the manufacturer standard J-channel termination treatment. In all cases, all top edge terminations shall fully cover and conceal siding cut edges or fastener perforations.

L. Soffit and Fascia Installation
   1. Install soffit panels in accordance with manufacturer instructions and in accordance with plan details.
   2. Terminate at soffit with the manufacture’s standard J-channel edging system with finish color matching the soffit material. Firmly attach J-channels to backer material.
   3. Install fascia materials with a uniform appearance with all edges properly hemmed to eliminate raw edges from view.
   4. Conceal fasteners for soffit and fascia to view to the greatest extent possible. Exposed fasteners shall be stainless steel in all cases and color match coated in cases where the fastener must be exposed to view. Install fastenings exposed to view with uniformity and with heads of the fasteners firmly seated against substrate materials.

** END OF SECTION **
SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. This Section covers brake metal fabrications, flashing components, and heavy-gauge brake metal fascia backer.

1.02 RELATED SECTIONS

A. Section 04 20 00 Unit Masonry.
B. Section 04 85 00 Stone Masonry Veneer.
C. Section 05 31 00 Steel Decking.
D. Section 05 40 00 Cold-Formed Metal Framing.
E. Section 07 30 00 Steep Slope Roofing.
F. Section 07 46 19 Steel Siding.

1.03 REFERENCES

A. ASTM International:
   2. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   6. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
   7. ASTM C1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.

B. Sheet Metal and Air Conditioning Contractors:

C. American Society of Mechanical Engineers Standards (ASME) ASME B18.6.3 - Machine Screws, Tapping Screws, and Metallic Drive Screws.

D. Society of Automotive Engineers (SAE) J78 - Steel Self-Drilling Tapping Screws.
1.04 SUBMITTALS

A. Shop Drawings:
   1. Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

B. Product Data: Submit data on manufactured components metal types, finishes, and characteristics.

C. Samples: Two 6-inch samples of each metal used.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inspect delivered sheet metal fabrications for damage and proper configuration.

B. Store delivered materials off the ground and protect from damage by exposure to weather.

C. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets that may become wet to ensure drainage.

D. Prevent contact with materials or chemicals that may cause discoloration or staining.

1.06 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fascia Backer
   1. Galvanized Steel: ASTM A653 steel sheet; Grade 33; 16 gauge, G90 zinc coating (0.0598-inch base metal; coating thickness 0.0015).

B. Soffit, Fascia, and Trim Material
   1. Reference Section 07 46 19 Steel Siding for manufacturer color matched products.
   2. ASTM A653 Hot-dip Galvanized Commercial Steel (CS) Intermediate Carbon Content Type B - 28-gauge (0.015-inch base metal) G60 galvanized steel.
   3. Pre-Finished Galvanized Steel Sheet: ASTM A755; structural steel sheet, G60 zinc coating for alternate materials.

C. Masonry Flashings
   1. Stainless Steel: ASTM A240 or ASTM A666 Type 304, fully annealed; smooth finish; thickness 24 gauge (0.025-inch).

2.02 ACCESSORIES

A. Sheet Metal Component Connections
   1. Self-drilling metal screws compliant with ASTM C1513 or ASTM C954 manufactured to ASME B18.6.3& SAE J78 dimensions.
   2. Corrosion-resistant coating for interior and protected applications.
   3. Type 410 stainless steel roof and exterior applications.

B. Reglets
   1. Masonry Recessed Type – Stainless steel.
2.03 SHEET METAL FABRICATIONS

A. Shop brake bend items in longest sections practicable for delivery to site. Provide lengths such that field cuts are not necessary.

B. Bent sections shall be true with squared edges forming straight lengths with uniform dimensions.

C. Hem exposed edges on underside 1/2-inch miter and seam corners.

D. Masonry Flashing
   1. Fabricate all masonry flashing with stainless steel.
   2. Fabricate header and sill flashing with pan-type configuration with end dams and front drip edges as detailed. Weld corner seams at end dams to be watertight.
   3. Fabricate through-wall flashing with 1-inch end dams at each joint between sections in a standing seam configuration and front drip edges as detailed. Weld corner seams at end dams to be watertight.
   4. Terminate all top edges of flashing in a reglet that is either cut into the masonry joint mortared in place or mated with a built-in reglet termination channel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify field conditions are clean and acceptable and are ready to receive Work.

3.02 PREPARATION

A. Remove any debris or obstructions to placement of sheet metal fabrications in true orientation, uniformly level and vertically plumb.

B. Secure unfastened substrate that may distort sheet metal fabrications with movement of underlying materials.

C. Fascia Backer
   1. Fit fascia backer components along the roof eave to form a uniform true roof edge line using laser or string line alignment techniques. Ensure roof edge is true and at a uniform elevation before placing distributed fasteners.
   2. Fasten fascia back with self-drilling screws at each upward flute on steel deck; maximum spacing 6 inches on center.

3.03 INSTALLATION

A. Fascia Backer
   1. Install fascia backer vertically plumb and horizontally level, accurately fitted, free from distortion or defects.
   2. Fasten fascia backer with self-drilling screws at each upward flute on steel deck; maximum spacing 6 inches on center.
   3. Fasten fascia backer to soffit cold-formed struts at each stud 24 inches on center.
   4. Miter corners of fascia backer such that trim face metal has firm support in corner locations.

B. Face Trim
   1. Reference Section 07 46 19 Steel Siding for installation of fabricated trim elements.

C. Soffit and Fascia Installation
   1. Install soffit panels in accordance with manufacturer instructions and in accordance with Plan details.
   2. Terminate all soffit with manufacture’s standard J-channel edging system with finish color matching the soffit material. Firmly attach J-channels to backer material.
3. Install fascia materials with a uniform appearance with all edges properly hemmed to eliminate raw edges from view.

4. Conceal fasteners for soffit and fascia from view to the greatest extent possible. Exposed fasteners shall be stainless steel in all cases and color match coated in cases where the fastener must be exposed to view. Install fastenings exposed to view with uniformity and with heads of fasteners firmly seated against substrate materials.

** END OF SECTION **
SECTION 07 84 00

FIRESTOPPING

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Firestopping for penetrations through fire-resistance rated walls and partitions, including both empty openings and openings containing cables, cable trays, pipes, ducts, conduits and other penetrating items.

B. Provide fire stopping for penetrations through fire rated walls identified on the Drawings.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 03 30 00 – Cast-in-Place Concrete.

C. Section 04 20 00 – Unit Masonry.

D. Section 07 30 00 – Steep Slope Roofing.

E. Section 07 46 19 – Steel Siding.

F. Section 07 92 00 – Joint Sealants.

1.03  REFERENCES

A. American Society for Testing and Materials (ASTM):

B. International Code Council:

C. Underwriter’s Laboratories Inc. (UL):
   1. UL 1479 – Fire Tests of Through-Penetration Firestops.

1.04  SUBMITTALS

A. Product Data:
   1. Manufacturer’s Material Safety Data Sheet (MSDS) for each type of material to be installed.
   2. Certification by firestopping material manufacturer that products supplied comply with local regulations controlling use of Volatile Organic Compounds (VOCs) and are nontoxic to building occupants.

B. Test reports: Product test reports from, and based on test performed by, qualified testing and inspecting agency, evidencing compliance of firestopping, with requirements based on comprehensive testing of current products.
C. Quality assurance data:
   1. Indicate type of materials, installation methods, and relationship to adjoining construction for each through-penetration firestop system, and each kind of construction condition penetrated and kind of penetrating item.
   2. Include firestop design designation of qualified testing and inspecting agency evidencing compliance with requirements for each condition.
   3. Submit documentation, including illustrations, from qualified testing and inspecting agency applicable to each through-penetration firestop configuration for construction and penetrating items.
   4. Submit qualification data for firms and persons as specified below to demonstrate capabilities and experience.

1.05 QUALITY ASSURANCE

A. Qualifications: Use installer certified, licensed, or otherwise qualified by firestopping material manufacturer as having necessary experience, staff and training to install manufacturer’s products in accordance with specified requirements.

B. Regulatory requirements:
   1. Provide firestopping complying with the following fire-test-response characteristics requirements:
      a. Firestopping tests shall be performed by qualified testing and inspecting agency such as Underwriter’s Laboratory (UL) or another agency acceptable to Authority Having Jurisdiction (AHJ).
      b. Through-penetration firestop systems shall be identical to those tested in accordance with ASTM E814, under conditions where positive furnace pressure differential of at least 0.01-inch of water column is maintained at a distance of 0.78-inch below fill materials surrounding penetrating item in test assembly.
      c. Through-penetration firestop system products shall bear classification markings of qualified testing and inspecting agency.
      d. Through-penetration firestop systems shall correspond to those indicated by reference to through-penetration firestop system designations listed by UL Fire Resistance Directory.
   2. Provide firestopping products containing no detectable asbestos as determined by methods specified in 40 CFR Part 763, Subpart F, Appendix A, Section 1, “Polarized Light Microscopy”.

C. Coordinate construction of openings and penetrating items to ensure designated through-penetration firestop systems are installed in accordance with specified requirements.

D. Owner and Engineer, or a designated representative, reserve right to review installed firestopping systems for compliance with specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer’s clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at project site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer’s requirements.

D. Comply with recommended procedure, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.
1.07 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).

B. Maintain minimum temperature before, during, and for 3 days after installation of materials.

C. Provide ventilation in areas to receive solvent-cured materials. Ventilation rate shall be in accordance with manufacturer’s instructions by either natural means, or where inadequate, by forced air circulation.

1.08 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 PRODUCT TYPES

A. Products listed are examples to be used only if appropriate to required installation. Other products may be necessary depending on conditions encountered.

2.02 SYSTEM DESCRIPTION

A. Use appropriate firestop material and installation as necessary to meet required fire rating of penetrated, fire-rated wall or floor.

B. Provide firestopping components compatible with each other, substrates forming openings, and items, if any, penetrating firestopping under conditions of service and application, as demonstrated by firestopping manufacturer based on testing and field experience.

C. Provide components for each firestopping system needed to install fill materials and to comply with performance requirements specified herein. Use only components specified by firestopping manufacturer and approved by qualified testing and inspecting agency for designated fire-resistance rated system. Accessories include, but are not limited to, the following:

1. Semi-refractory fiber (mineral wool) insulation.
2. Ceramic fiber.
3. Sealants used in combination with other forming materials to prevent leakage of fill materials in liquid state.
4. Fire-rated form board.
5. Temporary forming materials.
7. Collars.
8. Steel sleeves.

D. For products requiring mixing prior to application, comply with firestopping manufacturer’s instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time and other procedures needed to produce firestopping products of uniform quality with optimum performance characteristics for application indicated.
2.03 PERFORMANCE REQUIREMENTS

A. Provide firestopping systems produced and installed to resist spread of fire, according to requirements indicated herein, and passage of smoke and other gases.

B. Provide through-penetration firestop systems with ratings as determined by ASTM E814, where indicated and where penetrating items go through fire rated walls.

C. Provide firestopping products that do not deteriorate when exposed to view, traffic, moisture, and physical damage.
   1. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
   2. For firestopping exposed to view, provide products with flame-spread values of less than 25 and smoke-developed values of less than 450, as determined by ASTM E84.
   3. For firestopping in areas used as air plenum, provide products with flame-spread values of less than 25 and smoke-developed values of less than 50, as determined by ASTM E84.

2.04 MATERIALS

A. Sealants, caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic (EMT) and construction joints:
   1. Hilti FS-ONE.
   2. PFP Partners 4800 DW, 3600 EX.
   3. 3M CP 25 Fire barrier Caulk, Firedam 150+.
   4. Tremco IS, Fyre-sil, or Acrylic.
   5. or approved equal.

B. Approved manufacturers for other required products:
   1. Hilti.
   2. 3M.
   3. Dow Corning Corp.
   4. Or approved equal.

2.05 ACCESSORIES

A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces.

B. Dam material: Provide dam material, temporary or permanent, as recommended by firestopping manufacturer.

C. Provide forming materials, backer rods, and fire-resistant fillers as necessary.

D. Installation accessories: Clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify areas to receive the Work of this Section are ready.

B. Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of material. Ensure that substrates and surfaces are properly clean and dry and meet manufacturer’s instructions in all respects.

C. Do not proceed with Work until unsatisfactory conditions have been corrected.
3.02 PREPARATION

A. Clean openings immediately prior to installing firestopping to comply with recommendations of firestopping manufacturer and following requirements:
   1. Remove foreign materials from surfaces of opening substrates and from penetrating items that could interfere with adhesion of firestopping.
   2. Ensure surfaces to which firestop materials will be applied are free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

B. Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

C. Remove incompatible materials which may affect bond.

D. Install backing or damming materials to arrest liquid material leakage.

E. Maintain insulation around pipes penetrating fire separation (without interruption of vapor barrier).

3.03 APPLICATION

A. Install firestop materials in accordance with manufacturer’s instructions and published “Through-Penetration Firestop Systems” in UL Fire Resistance Directory.

B. Install material at walls or partition openings containing penetrating sleeves, piping, ductwork, conduit and other items, requiring firestopping.

C. Install forming or damming materials and other accessories of types required to support fill materials during application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings of designated through-penetration firestop systems. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.

D. Apply firestopping material in sufficient thickness to achieve rating equal to rating of wall or floor construction through which opening penetrates, to a uniform density and texture.

E. Completely fill voids and cavities formed by openings, forming materials, accessories and penetrating items. Apply materials to contact and adhere to substrates formed by openings and penetrating items.

F. Remove dam material after firestopping material has cured.

G. Do not proceed to enclose firestopping with other construction until Owner, inspection agency, or representative has reviewed firestopping.

H. Where deficiencies are found, replace firestopping to comply with requirements.

3.04 CLEANING

A. Clean surfaces adjacent to sealed openings to be free of excess firestop materials and soiling as Work progresses.
3.05 PROTECTION OF FINISHED WORK

A. Protect firestopping during and after curing period from contact with contaminating substances or damage from construction operations or other causes until completion of construction. If damage or deterioration occurs, remove damaged or deteriorated firestopping immediately and install new materials to produce firestopping complying with specified requirements.

** END OF SECTION **
SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Preparing sealant substrate surfaces.

B. Sealants and joint backing.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 03 30 00 – Cast-in-Place Concrete.

C. Section 08 11 00 – Steel Doors and Frames.

D. Section 40 23 23 – Inside Process Piping and Appurtenances.

E. Division 26 - Electrical.

1.03 REFERENCES


1.04 SUBMITTALS

A. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

B. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, perimeter conditions requiring special attention, and temperature limitations.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2  PRODUCTS

2.01  GENERAL

A. Compatibility:
   1. Provide joint sealants, joint fillers, and accessory joint materials that are compatible with one another and with joint substrates under the project conditions.
   2. Install joint sealants, joint fillers, and related joint materials that are non-staining to visible joint surfaces and surrounding substrate surfaces.

B. Provide colors selected by Engineer from manufacturer’s standard color charts, unless noted otherwise.

2.02  SEALANTS

A. Polyurethane Sealant:
   1. Use:
      a. For horizontal and vertical joints which are bordered on one or both sides by a porous building material such as concrete or masonry or a non-porous building material such as painted metal, anodized aluminum, mill finish aluminum, stainless steel, PVC, or porcelain tile.
      b. In locations such as interior and exterior door frame, window and louver perimeters; masonry joints along with, plumbing, HVAC, and electrical penetrations.
   2. Use two-component, non-sag sealant product.
   3. Only use material in newly opened containers.
   4. Color to match surrounding area or as selected by Engineer.
   5. Acceptable Manufacturers:
      a. Sika Corporation Sikaflex 2c.
      b. Masterseal NP2.
      c. Tremco Dymeric.
      d. or approved equal.

B. High performance silicone sealant:
   1. Use: Sealing of metal roof components and rainwear.
   2. Use single component, non-sagging, architectural grade, high performance, medium-modulus silicon specifically designed for use with metal roofs.
   3. Color to match surrounding area or as selected by Engineer. Roof and rainwear will use two different colors.
   4. Acceptable products:
      a. Dow Corning 791 Silicone.
      b. Pecora 864.
      c. Novaflex Metal Roof Silicon Sealant.
      d. Tremco Spectrem 3.
      e. or approved equal.

C. High-temperature exterior sealant: one part, gun grade, moisture curing, silicon sealant with a maximum service temperature of 450 degrees F.
   1. Applications:
      a. Sealing of high-temperature flashings.
   2. Approved Products:
      a. Omniseal by Sonneborn Building Products.
      b. Engineer-approved equal.

2.03  ACCESSORIES

A. Primer (if required): non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint-forming materials.
C. Joint Backing: closed cell, highly resilient polyethylene foam conforming to ASTM D7174 and ASTM D5249, Type II.

D. Bond Breaker: pressure-sensitive tape recommended by sealant manufacturer to suit application.

E. Masking Tape: non-staining; non-absorbent tape product compatible with joint sealants and adjacent joint surfaces that are suitable for masking.

PART 3 EXECUTION

3.01 GENERAL

A. Quality Assurance
   1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.
   2. Applicator Qualifications: Company specializing in performing the Work of this Section with minimum 3 years experience.

B. Maintain temperature and humidity recommended by sealant manufacturer during and after installation.

3.02 EXAMINATION

A. Verify that substrate surfaces are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.03 PREPARATION

A. Remove loose materials and foreign matter which might impair adhesion of sealant.

B. Perform adhesion test in accordance with manufacturer’s recommendations to determine if primer is required.

C. Clean and prime joints in accordance with manufacturer’s instructions.

D. Perform preparation in accordance with manufacturer’s instructions and ASTM C1193.

E. Protect elements surrounding the Work of this Section from damage or disfigurement.

3.04 INSTALLATION

A. Perform Work in accordance with sealant manufacturer’s requirements for preparation of surfaces and material installation instructions.

B. Where necessary to protect adjacent surfaces, mask adjacent surfaces with tape prior to priming and caulking.
   1. Use masking tape where required to prevent sealant or primer contact with adjoining surfaces that would be permanently stained or otherwise damaged by such contact or the cleaning methods required for removal.
   2. Apply tape so as to not shift readily and remove tape immediately after tooling without disturbing joint seal.

C. Perform installation in accordance with ASTM C1193.

D. Measure joint dimensions and size joint backers to achieve the following:
   1. Form all sealant joints with a depth of 1/2 to 2/3 of joint width.
   2. Surface bond area on each side not less than 75 percent of joint width.
E. Provide backer rod uniformly to depth required by sealant manufacturer for proper joint design using a blunt instrument.
   1. Fit securely by compressing backer material 25 to 50 percent so no displacement occurs during tooling.
   2. Avoid stretching, twisting, or distorting joint backer in any way.
   3. Install to achieve a neck dimension no greater than 1/3 the joint width.

F. Install bond breaker where joint backing is not used.

G. Vertical joints:
   1. Construct surface of vertical sealant joints with squarely formed surface profile.
   2. Position sealant joint face 1/16 inch behind face abutting edge of precast wall panels.

H. Horizontal joints:
   1. Use self-leveling or tooled, non-sagging materials as applicable.
   2. Provide uniform, slightly concaved surface profile.

I. Install sealant with a uniform surface appearance free of air pockets, foreign embedded matter, ridges, sags, depressions, and protrusions.

J. Install sealing to uniform cross-sectional shapes with depths relative to joint widths that allow optimum sealant movement capability as recommended by sealant manufacturer.

K. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.05 CLEANING AND REPAIRING

A. Remove sealant from adjacent surfaces in accordance with sealant and substrate manufacturers’ recommendations as work progresses.

B. Clean adjacent soiled surfaces.

C. Repair or replace defaced or disfigured finishes caused by work of this Section.

3.06 PROTECTION OF FINISHED WORK

A. Protect sealants until cured.

** END OF SECTION **
PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Thermally insulated steel doors.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 08 71 00 – Door Hardware.

C. Section 09 90 00 – Painting.

1.03 REFERENCES


D. National Association of Architectural Metal Manufacturers (NAAMM) HMMA 840 – Installation and Storage of Hollow Metal Doors and Frames; current version.

1.04 SUBMITTALS

A. Product Data: materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, grout, and finishes.

B. Shop Drawings: details of each opening, showing elevations, and frame profiles.

C. Installation Instructions: manufacturer’s published instructions, including any special installation instructions relating to this Project.

D. Manufacturer’s Certificate: certification that products meet or exceed specified requirements.

E. Submit documentation that any factory-applied primers or intermediate coatings provided on equipment or materials provided under this Section are compatible with the coating systems specified in Section 09 90 00.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2  PRODUCTS

2.01  MANUFACTURERS

A. Steel Doors and Frames:
   1. Ceco Door Products.
   2. Steelcraft.
   3. Engineer-approved equal.

2.02  STEEL DOORS

A. Exterior Doors
   1. Grade: ANSI A250.8, seamless and as scheduled on Plans.
   2. Core: polyurethane with "R" factor equal to 14.97.
   3. Top Closures for Out-swinging Doors: flush with top of faces and edges.
   4. Hardware Preparation: in accordance with DHI A115 Series, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
   5. Galvanizing: all components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653, G90 coating.
   6. Finish: factory-primed, for field finishing. Primer to be compatible with coating system specified in Section 09 90 00.
   7. Facing
      a. Main Entry Door – 6 panel Embossed Face – Exterior Face
      b. Other Doors – Flat Smooth Faced
      c. Interiors Faces – Flat Smooth Faced – Entry door may be embossed if standard

B. Interior Doors:
   1. Grade: ANSI A250.8, seamless and as scheduled on Plans.
   2. Hardware Preparation: in accordance with DHI A115 Series, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
   3. Finish: factory-primed, for field finishing. Primer to be compatible with coating system specified in Section 09 90 00.
   4. Provide minimum one-hour fire rating.
   5. Facing: Flat smooth face.

C. Refer to Plans for door, frame and hardware schedules for service and material thicknesses.

2.03  STEEL FRAMES

A. General:
   1. Finish: factory-primed, for field finishing. Primer to be compatible with coating system specified in Section 09 90 00.
   2. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

B. Door Frames: face welded, seamless with joints filled.

C. Refer to Plans for door, frame and hardware schedules.

2.04  ACCESSORY MATERIALS

A. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.
2.05 FABRICATION
   A. Fabricate doors and frames with hardware reinforcement welded in place. Provide mortar guard boxes.
   B. Fabricate frames as welded units.
   C. Close top of door with welded joint and bottom edge with inverted steel channel closure. Seal joints watertight.

PART 3 EXECUTION

3.01 GENERAL
   A. Quality Assurance
      1. Manufacturer: company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.
      2. Maintain at project site a copy of all reference standards dealing with installation.
   B. Delivery, Storage, and Protection
      1. Store in accordance with NAAMM HMMA 840.
      2. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

3.02 EXAMINATION
   A. Verify existing conditions before starting Work.
   B. Verify that opening sizes and tolerances are acceptable.

3.03 PREPARATION
   A. Coat inside of frames to be installed in masonry or to be grouted with bituminous coating prior to installation.

3.04 INSTALLATION
   A. Install in accordance with requirements of specified door grade standard.
   B. Coordinate frame anchor placement with wall construction.
   C. Coordinate installation of hardware.
   D. Touch up damaged factory finishes.

3.05 ERECTION TOLERANCES
   A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.06 ADJUSTING
   A. Adjust for smooth and balanced door movement.

** END OF SECTION **
SECTION 08 36 00
SECTIONAL OVERHEAD DOOR

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Insulated Sectional Overhead Doors.
B. Operating Hardware, tracks, and support.

1.02  RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete: Prepared opening in concrete. Execution requirements for placement of anchors in concrete wall construction.
B. Section 07 92 00 – Joint Sealers: Perimeter sealant and backup materials.

1.03  REFERENCES

   1. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.04  DESIGN / PERFORMANCE REQUIREMENTS

A. Wind Loads: Design and size components to withstand loads caused by pressure and suction of wind acting normal to plane of wall as calculated in accordance with applicable code.
   1. Design pressure of 20 pounds per square foot.
B. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

1.05  SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
B. Performance Standards: Provide test data validating the following:
   1. Door Section: Gloss retention, fade resistance, FDA compliance, cold crack performance, load to rebound, dent resistance impact.
   2. Drive Train: Spring cycle life, track, hinges, rollers, cable assembly, cable strength.
C. Shop Drawings:
   1. Indicate plans and elevations including opening dimensions and required tolerances, connection
details, anchorage spacing, hardware locations, and installation details.
   2. Provide drawings indicating track details, head and jamb conditions, spring shafts, anchorage,
accessories, finish colors, patterns and textures, operator mounts and other related information.

D. Manufacturer’s Certificates:
   1. Certify products meet or exceed specified requirements.
   2. Installer qualifications including manufacturer certifications when available.

E. Selection Samples: For each finish product specified, two complete sets of color chips representing
   manufacturer’s full range of available colors and patterns.

F. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm)
   square, representing actual product, color, and patterns.

G. Operation and Maintenance Data.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this Section
   with minimum five years documented experience.

B. Installer Qualifications: Authorized representative of the manufacturer with suitable documented
   experience with similar projects.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer’s unopened labeled packaging until ready for installation.

B. Protect materials from exposure to moisture until ready for installation.

C. Store materials in a dry, ventilated weathertight location.

1.08 PROJECT CONDITIONS

A. Pre-Installation Conference: Convene a pre-installation conference just prior to commencement of
   field operations, to establish procedures to maintain optimum working conditions and to coordinate
   this work with related and adjacent work.

B. Maintain environmental conditions including temperature, humidity, and ventilation within limits
   recommended by manufacturer. Do not install products under environmental conditions outside
   manufacturer’s recommended limits.

1.09 WARRANTY

A. Warranty: Manufacturer’s limited door and operator warranty for 10 years against delamination of
   polyurethane foam from steel face and all other components for 3 years or 10,000 cycles, whichever
   comes first.

1.10 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described
   in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2  PRODUCTS

2.01  MANUFACTURERS

A. Raynor, Inc.: 1101 East River Rd. P. O. Box 448; Dixon, IL 61021-0448 Email: request info (thegarage@raynor.com; Web: http://www.raynor.com.

B. Overhead Door Corp., 2501 S. State Hwy. 121, Suite 200, Lewisville, TX  75067. www.overheaddoor.com. E-mail: sales@overheaddoor.com.

C. Approved Commercial Door Manufacturer

2.02  INSULATED SECTIONAL OVERHEAD DOORS

A. General
   1. Door Operation: Manually operated, designed with hand chain operator.
   3. Wind Performance: Ultimate Wind Speed 115 mph, Exposure C.
      a. Deflection of the door to be maximum of 1/120th of door width.

B. Basis of Design:
   2. Approved Equal by Approved Manufacturer.

C. Insulated Steel Sectional Overhead Door shall have the following characteristics:
   1. Panel Sections:
      b. Panel Thickness: 2 inches.
      c. Sectional Panel Height: 24 inches.
      d. Insulated Core Construction: Pressure bonded with injected polyurethane foam insulated core with interior and exterior skins separated by continuous thermal break. R-18 Minimum.
      e. Section Joints: Tongue-and-groove joint for weather-tight closure between sections.
      f. Trussing: As required to meet wind load specifications.
   2. Material:
      a. Roll formed ASTM A 653 Sheet Steel hot-dipped galvanized (G40)
      b. Material Minimum Thicknesses:
         (2) Interior Sheet: 27-gauge – Stucco Texture Finish.
         (3) End Stiles: 16-gauge.
         (4) Hinge Reinforcement Plates Ends and Center: 19-gauge.
   3. Finish and Color:
      a. Two coat baked-on polyester:
      b. Interior color: Sandstone or White.
      c. Exterior color: Sandstone.
   4. Seals:
      b. Weather Seal at the Jamb.

D. Track:
   1. Material: Roll formed ASTM A 653 Sheet Steel hot-dipped galvanized (G40).
   2. Provide track as recommended by manufacturer to suit loading required and clearances available.
      a. Normal Headroom Configuration
      b. Size: 2 inch.
      c. 12 gauge.
      d. Type: Standard lift with partially vertical lift.
      e. Bracket Mount using adjustable brackets suitable for masonry mounting.
PART 3 EXECUTION

3.01 EXAMINATION
A. Examine the opening to ensure it is in a proper configuration to receive the sectional overhead door and opening dimensions and tolerances are within specified limits. Verify that openings are square, flush and plumb. Do not begin installation until substrates have been properly prepared.

B. Notify Project Engineer if conditions are not suitable to receive overhead door installation.

3.02 PREPARATION
A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION
A. Install overhead doors and track in accordance with approved shop drawings and the manufacturer’s printed instructions.

B. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.

C. Anchor assembly to wall construction and building precast concrete without distortion or stress.

D. Securely brace door tracks suspended from precast concrete plank.

E. Fit and align door assembly including hardware.

F. Lubricate bearings, torsion spring, and sliding parts, and adjust doors for proper operation, balance, clearance and similar requirements.

G. Ensure a weather-tight fit around door perimeter and adjust doors for proper operation, balance, clearance and similar requirements.

H. Protect installed products until completion of Project.

3.04 CLEANING AND ADJUSTING
A. Adjust door assembly to provide smooth operation and in full contact with weather stripping.

B. Clean doors and frames.

C. Remove temporary labels and visible markings.
3.05 PROTECTION

A. Do not permit construction traffic through overhead door openings after adjustment and cleaning.

B. Protect installed products until completion of Project.

C. Touch-up damaged coatings and finishes and repair minor damage before Substantial Completion.

***END OF SECTION***
SECTION 08 51 13
ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Work includes extruded aluminum windows with fixed glass, glass shop, or site glazed.

B. Includes window blinds between two sheets of glass.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 04 20 00 – Unit Masonry.

C. Section 07 92 00 – Joint Sealants.

D. Section 08 80 00 – Glazing.

1.03 REFERENCES

A. Aluminum Association:
   1. AA DAF-45 - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association:
   2. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
   7. AAMA MCWM-1 - Metal Curtain Wall manual.

C. American Society of Civil Engineers:

D. ASTM International:
10. ASTM E1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.

E. Consumer Product Safety Commission (CPSC)

F. Glass Association of North America:

G. National Fenestration Rating Council Incorporated:
   1. NFRC 100 - Procedures for Determining Fenestration Product U-Factors.

H. SSPC: The Society for Protective Coatings:
   1. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).
   2. SSPC Paint 25 - Red Iron Oxide, Zinc Oxide, Raw Linseed Oil, and Alkyd Primer.

1.04 PERFORMANCE REQUIREMENTS

A. Design and size components to withstand dead and live loads caused by positive and negative wind pressure acting normal to plane of wall as measured in accordance with ASTM E330.

B. Deflection: Limit member deflection to flexure limit of glass or 1/175 of longer dimension with full recovery of glazing materials.

C. Assembly: To accommodate, without damage to components or deterioration of seals, movement between window and perimeter framing, deflection of lintel.

D. Thermal Transmittance of Assembly: Maximum U Value of 0.45 Btu per square foot per hour per degree F when measured in accordance with NFRC 100.

E. Air Infiltration: Limit air infiltration through assembly to 0.1 cfm/min/square foot of wall area, measured at reference differential pressure across assembly of 6.24 psf as measured in accordance with ASTM E283.

F. Water Leakage: None, when measured in accordance with ASTM E331, ASTM E1105, or ASTM E547.

1.05 SUBMITTALS

A. Submit in accordance with Specification Section 01 00 00.

B. Shop Drawings:
   1. Include plans, elevations, sections, details, hardware, and attachments to other work, operational clearances, installation details, opening dimensions, rough opening tolerances, affected related work and installation requirements.
   2. Provide component complete with materials, manufactured product literature, sealants, and finishes.
   3. Product Data: Submit component dimensions, anchorage and fasteners, glass, internal damage, and typical details.
C. Samples: Submit two samples illustrating range of colors and textures available.

D. Submit manufacturer’s glazing instructions.

E. Submit warranty compliant with these Specifications.

1.06 QUALITY CONTROL

A. Perform work in accordance with the following:
   1. Aluminum Windows: Fabricate window assemblies in accordance with AAMA 101 for types of windows required.
   2. Insulated glass: Fabricate insulated glass units in accordance with GANA glazing manual.

1.07 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 ALUMINUM WINDOWS

A. FRAMING SYSTEM
   1. Anodized extruded aluminum frames with thermal break.
   2. Aluminum Extrusions: Alloy and temper recommended by aluminum storefront manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070-inch wall thickness at any location for the main frame and complying with ASTM B221: 6063-T6 alloy and temper.
   4. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
   5. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum framing members, trim hardware, anchors, and other components.
   6. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
   7. Basis of Design:
      a. Trifab VG 451T Framing System manufactured by Kawneer Company, Inc.
      b. Color: Light Bronze #26; Architectural Class I, Aluminum Association Finish AA-M10C21A44.

2.02 GLASS AND GLAZING MATERIALS

A. Glass and glazing materials: Type A as specified in Section 08 80 00. Glass may be factory glazed under this Section or field glazed under Section 08 80 00.

B. Glazing to include internal 5/8-inch muttons in a 2H:4V pattern.

2.03 BLINDS ENCLOSURE

A. Furnish the aluminum window frames with a sealed enclosure, glazed with 1/4-inch plate glass, to place horizontal louver blinds for installation by the General Contractor. Blinds will be installed in a single configuration and need not be operable.

B. The head of the enclosure shall have thickened materials to support mounting of aluminum horizontal louver blinds.
C. Enclosures shall be generally airtight with synthetic rubber perimeter gaskets to prevent migration of dust into the blinds space.

D. Fabricate enclosures with aluminum framing fit securely within the interior surface of window frame and fixed securely in place.

E. Enclosures shall be removable for maintenance of blinds.

2.04 PERIMETER SEALANT MATERIALS

A. Sealant and Backing Materials: As specified in Section 07 92 00.

2.05 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Arrange fasteners and attachments to ensure concealment from view.

E. Prepare components with internal reinforcement for operating hardware.

F. Provide internal reinforcement in mullions with galvanized steel members to maintain rigidity.

G. Permit internal drainage weep holes and channels to migrate moisture to exterior. Provide internal drainage of glazing spaces to exterior through weep holes.

H. Assemble insect screen frame, miter and reinforce frame corners. Fit mesh taut into frame and secure.

I. Fit frame with four spring loaded steel pin retainers.

2.06 ACCESSORIES

A. Fasteners and Anchors: Stainless Steel.

B. Bituminous paint: Fibered asphaltic type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify site opening conditions.

B. Verify wall openings are ready to receive work of this Section.

C. Beginning of Installation means acceptance of substrate.

D. Verify flashing is installed properly for protection of the window and drainage beneath it.
3.02 INSTALLATION

A. Install windows in compliance with Drawings, Shop Drawings, and manufacturer's written instructions for installing aluminum windows.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.

C. Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.

D. Install aluminum windows and components to drain condensation, water penetrating joints, and moisture migrating within aluminum-framed storefront to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

F. Anchor window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.

G. Coordinate attachment and seal of perimeter air barrier and vapor barrier materials.

H. Install operating hardware.

I. Install glass in accordance with manufacturer’s instructions and Section 08 80 00.

J. Apply sealants at joints and intersections and at opening interior and exterior perimeter to provide a watertight installation. Wipe off excess material and leave exposed surfaces and joints clean and smooth.

3.03 TOLERANCES

A. Maximum variation from level or plumb: 1/16 inch every 3 feet of non-cumulative or 1/8 inch per 100 feet, whichever is less.

3.04 CLEANING

A. Clean aluminum surfaces immediately after installing aluminum windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

B. Clean glass immediately after installation. Comply with glass manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Remove protective material from prefinished aluminum surfaces.

E. Wash surfaces down with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

F. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

** END OF SECTION **
PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Hardware for steel doors.

B. Weather stripping, seals, and door gaskets.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 08 11 00 – Steel Doors and Frames.

1.03  REFERENCES


1.04  SUBMITTALS

A. Shop Drawings:
   1. Indicate locations and mounting heights of each type of hardware, schedules, and catalog cuts.
   2. Submit manufacturer's parts lists and templates.

B. Samples:
   1. Submit one sample of hinge, surface bolt, and hold open illustrating style, color, and finish.
   2. Samples will be returned to supplier.

C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

D. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.

E. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05  MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2  PRODUCTS

2.01  MANUFACTURED UNIT(S) OR MATERIALS

A. Provide items as listed in "Door Schedule" and "Door Hardware Schedule" on the Plans complete to function as intended. Hardware numbers used in the schedule represent the level of quality required.

B. Furnish all material with proper type screws and fasteners, properly boxed and labeled.

C. Hardware scheduled is approved for installation. Alternate brand hardware equal to that listed may be substituted only with written approval of Engineer.
2.02 MANUFACTURERS – BASIS OF DESIGN – EQUAL PERMITTED WITH APPROVAL

A. Hinges:
   1. Stanley Works (STN).

B. Exit Devices:
   1. Von Duprin, Inc. (VDP).
      a. Part of exit assembly.

C. Latch sets:
   1. Schlage (SCH).

D. Cylinder:
   1. Medeco (ME).
      a. Provide temporary cylinders during construction.
      b. Final cylinders will be Medeco provided by Owner.

E. Door Closers:
   1. LCN (LCN).

F. Gasketing/Astragals/Meeting Stiles/Brush Sweeps:
   1. National Guard Products (NGP).

G. Kick Plates:
   1. Ives (IVES).

2.03 GENERAL REQUIREMENTS FOR DOOR HARDWARE PRODUCTS

A. Provide products that comply with the following:
   1. Applicable provisions of federal, state, and local codes.

B. Finishes: identified in schedule on Contract Drawings.

2.04 HINGES

A. Provide three hinges per door leaf.

2.05 STRIKE PROTECTION PLATES

A. 10 inches high and full width less clearance for hardware, perimeter gasket, and door frame.

B. Material: 0.050-inch-thick and beveled on four edges.

2.06 LOCKSETS LATCHES

A. Passage latches used in conjunction with dead locks.

2.07 GASKETING

A. Provide perimeter weather-strip at each exterior door opening for the head and side jambs.

B. Provide channel-concealed sweep at bottom of doors.
PART 3 EXECUTION

3.01 GENERAL

A. Quality Assurance
   1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum 3 years of documented experience.
   2. Hardware Supplier Qualifications: Company specializing in supplying commercial door hardware with 3 years of experience.

B. Delivery, Storage, and Protection
   1. Package hardware items individually; label and identify each package with door-opening code to match hardware schedule.
   2. Handle all items in a manner to prevent damage. Marred, defaced, damaged, and defective items will be rejected.

C. Coordination
   1. Coordinate the work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware.
   2. Furnish templates for door and frame preparation.
   3. Coordinate Owner's keying requirements during the course of the Work.

D. Warranty
   1. Provide 10-year warranty for door closers and 3-year warranty on all other hardware.

E. Maintenance Products
   1. Provide special wrenches and tools applicable to each different or special hardware component.
   2. Provide maintenance tools and accessories supplied by hardware component manufacturer.

3.02 EXAMINATION

A. Verify that doors and frames are ready to receive work and dimensions are as indicated on Shop Drawings.

3.03 INSTALLATION

A. Install hardware in accordance with manufacturer's instructions and applicable codes.

B. Use templates provided by hardware item manufacturer.

C. Mounting heights for hardware from finished floor to centerline of hardware item: as listed in Schedule, unless otherwise noted.

3.04 FIELD QUALITY CONTROL

A. Provide an Architectural Hardware Consultant to inspect installation and certify that hardware and installation has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.05 ADJUSTING

A. Adjust hardware for smooth operation.
3.06 PROTECTION OF FINISHED WORK
   A. Do not permit adjacent work to damage hardware or finish.

3.07 SCHEDULE
   A. Refer to Contract Drawings.

** END OF SECTION **
SECTION 08 80 00

GLAZING

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Glass and glazing of windows and doors.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 08 51 13 – Aluminum Windows.

1.03 REFERENCES

A. American National Standards Institute:

B. American Society of Civil Engineers:

C. ASTM International:
   1. ASTM Glass and Glazing Standards for the Building Industry (GLASSCMP).

D. Consumer Products Safety Commission:

E. Glass Association of North America:
   1. GANA - Sealant Manual.

F. Insulated Glass Manufacturers Alliance (IGMA)
   1. IGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

G. Consumer Products Safety Commission (CPSC)
   1. 16 CFR 1201 – Safety Standards for Architectural Glazing Materials
1.04 SUBMITTALS

A. Product data:
   1. Glazing Units
      a. Provide structural, physical, and environmental characteristics, size limitations, special handling or installation requirements, and manufacturer’s product literature.
      b. Setting Components and Glazing Setting Techniques.
   2. Glazing Sealants, Compounds, and Accessories: Provide chemical, functional, and environmental characteristics, limitations, and special application requirements. Identify available colors where exposed.
   3. Verification Samples: Muntin finish, glazing materials.

B. Submit warranty compliant with these Specifications.

1.05 QUALITY CONTROL


B. Comply with published recommendations of IGMA Publication for Insulating Glass: IGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

C. Installer Qualifications:
   1. An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project.
   2. Installer work has resulted in glass installations with a record of successful in-service performance.
   3. Employs glass installers for this Project who are certified under the National Glass Association Glazier Certification Program as Level-2 (Senior Glaziers) or Level-3 (Master Glaziers).

D. Source Limitations for Glass: Obtain all glazing products through a single manufacturer.

E. Insulating-Glass Certification: Permanently marked on spacers any of the following certifications:
   1. Insulating Glass Certification Council.
   2. Associated Laboratories, Inc.
   3. Insulating Glass Manufacturers Alliance.

1.06 DELIVERY, HANDLING AND STORAGE

A. Glass must be handled carefully during transportation and installation to avoid edge damage and reduce the risk of later glass fracture.

B. Protect glazing materials from environmentally adverse conditions to avoid sustained exposure to wet conditions prior to installation.

C. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
1.07 WARRANTY

A. Manufacturer’s Warranty on Insulating Glass: Manufacturer’s standard form in which the insulating glass unit manufacturer agrees to replace insulating-glass units that deteriorate during normal use within the specified warranty period. Deterioration of insulating glass units is defined as an obstruction of vision by dust, moisture, or a film on the interior surfaces of the glass caused by a failure of the hermetic seal that is not attributed to glass breakage, improper installation, or cleaning and maintenance that is contrary to the manufacturer’s written instructions.

B. Warranty Period: 5 years from date of Substantial Completion.

1.08 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 GLASS:


B. Insulating-Glass Units
   1. Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace and complying with requirements specified in this Article and in Part 2 “Insulating-Glass Units” Article.
   2. Fully tempered Clear Glass Lites.
   3. Overall Unit Thickness: Minimum 1 inch.
   5. Spacer Specifications: Manufacturer’s standard spacer material and construction complying with the following requirements:
      a. Spacer Material: Aluminum with mill or clear anodic finish.
      b. Desiccant: Molecular sieve or silica gel, or blend of both.
      c. Corner Construction: Manufacturer’s standard corner construction.
   6. Construction:
      b. Construction: 1/4-inch clear glass plus 1/2-inch air space plus 1/4-inch clear glass.
      c. Provide an internal muntin grid with joints between specified muntin bars, tightly closed to be indiscernible. Muntin alignment shall provide uniform individual pane openings, be fixed securely in place, and be installed at right angles to the glazing unit.

C. Manufacturers:
   1. Cardinal IG.
   2. Libby-Owens-Ford.
   3. Vitro.
   4. Approved equal.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within acceptable tolerance.

B. Verify surfaces of glazing channels or recesses are clean, free of obstructions impeding moisture movement, weeps are clear, and are ready to receive glazing.

C. Beginning of installation means acceptance of substrates.
3.02 PREPARATION
A. Clean contact surfaces with solvent and wipe dry.
B. Seal porous glazing channels or recesses with substrate-compatible primer or sealer.
C. Prime surfaces in accordance with manufacturer’s instructions.
D. Identify positioning of glazing units so individual panes formed by the internal muntin grid result in all pane openings being of the same uniform size.

3.03 INSTALLATION
A. Perform installation in accordance with GANA Glazing Manual.
B. Install in accordance with glazing and frames manufacturer’s instructions.
C. Provide properly sized setting blocks (min. 1/4-inch-thick) to raise the edge of the insulated glass unit glass above water level in the glazing pocket. Setting blocks must be wide enough to support the entire insulated glass unit cross section, notches and positioned to allow water to drain to weep holes.
D. Provide anti-walk pads to separate glass edge from metal. Follow GANA glazing guidelines.
E. Align and install insulated glass units to provide equal muntin grid pane openings throughout the window lite, aligning the grid horizontally level and vertically plumb.
F. Exterior Wet Method (Preformed Tape and Sealant) Installation:
   1. The sealant used must be compatible with glazing tape compound.
   2. Cut glazing tape to length and set against permanent stops, 3/16 inch below sight line. Seal corners by butting tape and dabbing with compatible sealant.
   3. Apply heel bead of sealant along intersection of permanent stop with frame ensuring full perimeter seal between glass and frame to complete continuity of air and vapor seal.
   4. Place setting blocks at 1/4 points with edge block no more than 4 inches from corners.
   5. Rest glazing on setting blocks and push against tape and heel bead of sealant with sufficient pressure to attain full contact at perimeter of glass unit.
   6. Install removable stops, with spacer strips inserted between glazing and applied stops, 1/4 inch below sight line.
   7. Fill gap between glazing and stop with elastomeric glazing sealant to depth equal to frame on glazing, but not more than 3/8 inch below sight line.
   8. Apply cap bead of elastomeric glazing sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.

3.04 CLEANING
A. Remove glazing materials from finish surfaces.
B. Remove labels from glass after work is complete.
C. Clean glass and adjacent surfaces.

3.05 PROTECTION OF FINISHED WORK
A. After installation, mark pane with an ‘X’ by using removable plastic tape or paste.

** END OF SECTION **
SECTION 09 90 00
PAINTING

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Surface preparation and field application of paint for process piping, miscellaneous metals, doors and frames.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.
B. Section 05 50 00 – Metal Fabrications.
C. Section 08 11 00 – Steel Doors and Frames.
D. Section 40 23 23 – Inside Process Piping and Appurtenances.

1.03  REFERENCES

B. National Association of Pipe Manufacturers, Inc. (NAPF) 500-3-04 – Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Internal Linings.
C. Steel Structures Painting Council, Surface Preparation Specification No. 6 (SSPC-SP6) – Commercial Blast Cleaning.

1.04  SUBMITTALS

A. Submit complete list of materials and painting schedule for all coats required for each type of surface.
   1. Provide explanation of all abbreviations, symbols, codes, and other designations contained in schedule.
   2. List in format permitting identification by container labels.
      a. Note recommended dry film thickness, type of system, finish and surface preparation for each coat, and each system on list.
      b. Deliver no material to job site until list is reviewed by Engineer.

B. Submit complete catalog describing all painting systems and types available and proposed.

C. Samples: Submit two samples illustrating range of colors and textures available for each surface finishing product scheduled.

D. Submit one copy of Material Safety Data Sheet (MSDS) for all paint, coatings, and related materials to Engineer prior to delivery of materials on site.

E. Submit documentation that any factory-applied primers or intermediate coatings provided on equipment or materials to be painted are compatible with coating systems specified in this Section.

F. Manufacturer’s instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.
1.05 QUALITY CONTROL

A. Before proceeding with painting, finish one complete sample panel, space, room or item of each color scheme showing selected color, finish texture, and workmanship. Request review and approval by Engineer of first finished sample panel, space, room or item. Use first acceptable sample panel, space, room or item as the standard for similar work throughout.
   1. Approved samples will be kept on job for comparison.
   2. Engineer reserves right to select unopened containers of materials furnished on job and have materials tested at an approved laboratory.
   3. Owner will pay for first tests. Retests of rejected materials and tests of replacement materials to be paid for by Contractor. Remainder of contents of containers not required for testing will be returned to Contractor.

B. Include on label of each container:
   1. Manufacturer’s Name and Type of Material.
   2. Federal Specification Number, if applicable.
   3. Manufacturer’s Stock Number and Batch Number.
   5. Thinning Instructions.
   6. Application Instructions.
   7. Color.

1.06 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 PAINT

A. Surfaces requiring painting:
   1. Inside process piping and pipe supports.
   2. Doors and frames.

B. Process piping: Tnemec System Series 66-1:
   2. First coat: Tnemec 66-1211 Epoxoline Primer; 3 to 5 mils dry film thickness.
   3. Second coat: Tnemec Series 66 Hi-Build Epoxoline; 4 to 6 mils minimum dry film thickness for each coat.
   4. Color:
      a. Potable water – Safety Blue.
   5. Total dry film thickness: 7 to 11 mils.

C. Interior and Miscellaneous Metals:
   1. Surface preparation: Uniformly abrade surface to provide a minimum 1.0 mil anchor profile.
   2. First coat: Tnemec N69-Color Hi-Build Epoxoline II (2 – 3 DFT).
   4. Top coat: Tnemec 73-Color Endura-Shield (2 – 3 DFT).
   5. Color: To be determined by Owner.
   6. Total dry film thickness: 4 to 6 mils.

D. Interior Doors, frames, and interior structural steel:
   1. Surface preparation: Uniformly abrade surface to provide a minimum 1.0 mil anchor profile.
   2. First coat: Tnemec 69-Color Hi-Build Epoxoline (2 – 3 DFT).
   4. Color: To be determined by Owner.
   5. Total dry film thickness: 4 to 6 mils.
E. Exterior Doors and frames:
1. Surface preparation: Uniformly abrade surface to provide a minimum 1.0 mil anchor profile.
5. Color: To be determined by Owner.
6. Total dry film thickness: 8 to 10 mils.

F. Exterior Metal Fabrications Ungalvanized and pipe supports:
1. Surface preparation: SSPC-SP 6/NACE No.3 Commercial Blast – Angaur Profile 1.5 Mils.
3. Intermediate Coat: Tnemec 69-Color Hi-Build Epoxoline (3.5 – 4.5 DFT).
4. Top coat: Tnemec 73-Color Endura-Shield (2.5 – 3 DFT).
5. Color: To be determined by Owner.
6. Total dry film thickness: 8 to 10 mils.

PART 3 EXECUTION

3.01 GENERAL

A. Definitions: Conform to ASTM D16 for interpretation of terms used in this Section.

B. All factory applied primers and intermediate coatings are to be compatible with coating systems specified in this Section.

C. Qualifications:
1. Manufacturer: company specializing in manufacturing products specified in this Section with minimum 3 years documented experience.
2. Applicator: company specializing in performing the Work of this Section with minimum 3 years documented experience approved by manufacturer.

D. Regulatory Requirements:
1. Conform to applicable code for flame- and smoke-rating requirements for finishes.

E. Delivery, Storage, and Handling:
1. Deliver products to job site in original unopened containers with labels intact; inspect to verify acceptability. Store only acceptable materials at job site.
2. Container label to include manufacturer’s name, type of paint, brand name, lot number, and brand code.
3. Store material in manner as to protect surrounding surfaces from splatter, spillage, or discoloration.
4. Store material at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in well ventilated area, away from excessive heat, sparks, flame, direct sunlight, and as required by manufacturer’s instructions.

F. Environmental Requirements:
1. Comply with manufacturer’s recommendations as to temperature, dew point and humidity, and surface conditions under which coating or coating system can be applied. Do not apply finish in areas where dust is being, or is likely to be, generated. Do not apply paint on exterior surface exposed to sun or when surface temperature exceeds 105 degrees F. Apply all finish under adequate illumination.
2. Ventilate spaces so as to not affect workers in adjoining spaces. Comply with all applicable safety codes and ordinances.

G. Extra Materials:
1. Provide 1 gallon of each color, type, and texture to Owner.
2. Label each container with color, type, texture, and room locations, in addition to the manufacturer’s label.
3.02 EXAMINATION

A. Inspect all surfaces requiring paint prior to application: Examine surfaces scheduled to be painted for conditions that will adversely affect execution, performance, or quality of work and which cannot be corrected by normal cleaning, sanding, and filling of cracks and holes.

B. Do not proceed with surface preparation or coating application until conditions are suitable.

C. Test shop-applied coating for compatibility with subsequent cover materials.

3.03 WORK NOT INCLUDED

A. Finished Metal Surfaces: Metal surfaces of anodized aluminum, stainless steel, chromium plate, copper bronze and similar finished materials will not require painting, except as otherwise directed.

B. Labels: Do not paint over any required labels, such as Underwriters’ Laboratories and Factory Mutual, or any equipment identification, performance rating, name or nomenclature parts.

3.04 SURFACE PREPARATION, GENERAL

A. Perform preparation and cleaning procedures in strict accordance with the paint manufacturer’s instructions and as specified, for each particular surface condition.

B. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items to be painted, or provide surface-applied protection prior to preparation and painting operations. Remove obstructions to permit complete painting of all items and adjacent surfaces. Following completion of painting of each space or area, install removed items using workers skilled in the trade involved.

C. Clean surfaces to be painted before applying surface treatments. Remove oil and grease prior to mechanical cleaning. Program the cleaning and painting so that contaminants from the cleaning process do not fall onto newly painted surfaces.

D. Ensure surface is prepared as recommended by manufacturer.

E. Prepare all surfaces to be painted in skillful manner with objective to obtain clean, dry surface; do not painting before the prepared surfaces are approved by Engineer.

3.05 APPLICATION

A. Apply as recommended by manufacturer on properly prepared surface.

B. Use applicators and techniques best suited for the type of material being applied.

C. Do not paint surfaces that are not dry.

D. Apply at specified rates to achieve specified dry mil thickness.

E. Apply each additional coat only after preceding coat has thoroughly dried.

F. Brush out sufficiently to eliminate sags, runs, crawls, and brush markings.

G. Spraying:
   1. Apply in fine even sprays; thin according to manufacturer’s recommendations.
   2. Where necessary, follow by brushing to ensure uniform coverage and to eliminate wrinkling, blistering, and air holes.
   3. If interior spraying becomes detrimental to equipment or objectionable to personnel, Engineer reserves the right to require brush painting.
H. Clean up all spills or splatter paint daily.

I. Finish surfaces free from paint runs, drops, ridges, waves, laps, brush marks, and variation in color, texture, and finish.

J. Give special attention to edges, corners, crevices, welds, and rivets to ensure surfaces receive film thickness equivalent to that of adjacent surface.

3.06 FIELD QUALITY CONTROL

A. Notify Engineer when surface preparation is complete and when subsequent coats have been applied for inspection of work.

3.07 PROTECTION AND CLEANING

A. Protect all surfaces from dust and debris resulting from surface preparation process and from painting.

B. Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct damages by cleaning, repairing or replacing, or repainting, as directed by Engineer. Provide “Wet Paint” signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

C. Following completion of painting of each space or area, install removed items using workers skilled in the trade involved.

D. Flanged and grooved and shouldered couplings must remain fully operational after painting operations are complete. Nuts, bolts, and washers must be removable, and grooved and shouldered coupling components must be removable.

E. Remove paint from floors and other surfaces not specified to receive paint.

F. When painting is complete, remove from premises all debris that is the result of painting operations, and dispose of in accordance with all applicable federal, state, and local regulations.

** END OF SECTION **
SECTION 12 21 13
HORIZONTAL LOUVER BLINDS

PART 1  GENERAL

1.01  SUMMARY OF WORK
A. Section includes horizontal metal slat louver blinds and operating hardware.

1.02  RELATED SECTIONS
A. Section 08 51 13 – Aluminum Windows

1.03  REFERENCES

1.04  SUBMITTALS
A. Shop Drawings: Indicate opening sizes, tolerances required, method of attachment, clearances, and operation.

B. Product Data: Submit data indicating physical and dimensional characteristics, operating features, and certification blinds are manufactured in accordance with ANSI/WCMA A100-1 safety standards.

C. Samples: Submit two samples 4 inches long illustrating slat materials and finish, type and color.

D. Manufacturer's Installation Instructions: Submit special procedures including conditions requiring special attention.

1.05  QUALIFICATIONS
A. Manufacturer: Company specializing in manufacturing products specified in this Section with a recognized national market presence in the manufacture and distribution of horizontal louver blinds.

1.06  MOCKUP
A. Construct mockup of one blind positioned in the enclosure fabrication specified in Section 08 51 13 Aluminum Windows specification.

B. Incorporate accepted mockup as part of Work.

1.07  FIELD MEASUREMENTS
A. Verify field measurements prior to fabrication.

1.08  COORDINATION
A. Coordinate the Work with window fabricator and installation to ensure blinds are properly fitted with the containment enclosure.

1.09  EXTRA MATERIALS
A. Supply five additional slats.

B. Supply 20 feet of additional lift cord.
1.10 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 HORIZONTAL LOUVER BLINDS

A. Manufacturers:
   1. Levolor.
   3. Approved Equal.

2.02 COMPONENTS

A. Metal Slats: Spring tempered pre-finished aluminum radiused slat corners, with manufacturing burrs removed.
   1. Width: 1 inch.
   2. Thickness: 0.011 inch minimum.
   3. Color: Selected by Owner from standard color pallet.

B. Slat Support: Woven polypropylene cord, ladder configuration.

C. Headrail: Pre-finished, formed aluminum box, with end caps; internally fitted with hardware, pulleys, and bearings for operation; same depth as width of slats.
   1. Color: Same as slats.

D. Bottom Rail: Pre-finished, formed aluminum with top side shaped to match slat curvature with end caps.
   1. Color: Same as slats.

E. Lift Cord: Braided nylon or polypropylene continuous loop.
   1. Free end [weighted looped through wall mounted spring tensioned pulley.]

F. Fabricate blinds to fit within openings with uniform edge clearance of fabricated window enclosure.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify openings are ready to receive work.

B. Verify the blinds enclosure is properly prepared to receive blinds.

3.02 INSTALLATION

A. Install blinds.

B. Secure in place with flush countersunk or concealed fasteners.

C. Place intermediate head supports as required by manufacturer.
3.03 ERECTION TOLERANCES
   A. Maximum Variation of Gap at Window Opening Perimeter: 1/4 inch.
   B. Maximum Offset From Level: 1/8 inch.

3.04 ADJUSTING
   A. Adjust blinds for smooth operation.

3.05 CLEANING
   A. Clean blind surfaces just prior to occupancy.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make his portion of the Mechanical Work a finished and working system.
C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
D. Scope of Work:
   1. Plumbing Work shall include, but is not necessarily limited to:
      a. Furnish and install all items listed in the Plumbing Material List.
      b. Furnish and install domestic water backflow preventer as required by Code.
      c. Furnish and install a complete non-potable water piping system including cold piping within the building. Insulate all piping as specified.
      d. Furnish and install a complete sanitary sewer system.
      e. Furnish and install site sanitary sewer piping and cleanouts.
      f. Furnish and install engine exhaust piping.
      g. Furnish and install fuel tank vent piping.
   2. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:
      a. Furnish and install package wall mount air handling units complete with wall openings.
      b. Furnish and install all terminal heating units.

1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

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

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

<table>
<thead>
<tr>
<th>Distribution/Nominal Voltage</th>
<th>Utilization Voltage</th>
</tr>
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<tbody>
<tr>
<td>120</td>
<td>115</td>
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<tr>
<td>208</td>
<td>200</td>
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<td>240</td>
<td>230</td>
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<tr>
<td>277</td>
<td>265</td>
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<tr>
<td>480</td>
<td>460</td>
</tr>
</tbody>
</table>

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

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

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

4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.

5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
   a. Light fixtures.
   b. Gravity flow piping.
   c. Electrical busduct.
   d. Electrical cable trays, including access space.
   e. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:
1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
   a. Packaged Terminal Air Handling Units.

2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.

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

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.

2. Installs and wires all remote control devices furnished by the Mechanical Contractor when so noted on the Electrical Drawings.

3. Provides motor control and temperature control wiring, where so noted on the drawings.

4. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.

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

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

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

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

C. Compliance with Codes, Laws, Ordinances:
   1. Conform to all requirements of the City of Ankeny, Iowa’s Codes, Laws, Ordinances and other regulations having jurisdiction.
   2. Conform to all State Codes.
   3. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.
   4. If there is a discrepancy between the codes and regulations and these specifications, the Owner/Engineer shall determine the method or equipment used.
   5. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Owner/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
   6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
   7. If there is a discrepancy between manufacturer’s recommendations and these specifications, the manufacturer’s recommendations shall govern.
   8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

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

E. Examination of Drawings:
   1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
   2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
   3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either on the drawings or in the specifications, it shall be included in this contract.

7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.

8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
   a. Any item listed as furnished shall also be installed, unless otherwise noted.
   b. Any item listed as installed shall also be furnished, unless otherwise noted.

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

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

1.5 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.
   1. Submittals List:
      | Referenced Specification Section | Submittal Item |
      |----------------------------------|----------------|
      | 22 10 30                         | Plumbing Specialties |

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
   1. Transmittal: Each transmittal shall include the following:
      a. Date
      b. Project title and number
      c. Contractor’s name and address
      d. Division of work (e.g., plumbing, heating, ventilating, etc.)
      e. Description of items submitted and relevant specification number
      f. Notations of deviations from the contract documents
      g. Other pertinent data
   2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
      a. Date
      b. Project title and number
c. Owner/Engineer

d. Contractor and subcontractors’ names and addresses

e. Supplier and manufacturer’s names and addresses

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

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

h. Notations of deviations from the contract documents

i. Other pertinent data

j. Provide space for Contractor’s review stamps

3. Composition:

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

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

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

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

5. Contractor’s Approval Stamp:

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

b. Unstamped submittals will be rejected.

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

1) Only approved manufacturers are used.

2) Addenda items have been incorporated.

3) Catalog numbers and options match those specified.

4) Performance data matches that specified.

5) Electrical characteristics and loads match those specified.

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

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

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

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

d. The Contractor shall review, stamp and approve all subcontracts’ submittals as described above.

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

6. Submittal Identification and Markings:

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

b. The Contractor shall clearly indicate the size, finish, material, etc.
c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Owner/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Owner/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Owner/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Owner/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Owner/Engineer's approval.

C. Electronic Submittal Procedures:
1. Distribution: Email submittals as attachments to all parties designated by the Owner/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
   a. Submittal file name: 22 XX XX.description.YYYYMMDD
   b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.6 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.
B. Format:
   1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Engineer.
   2. Submit in Excel format.
   3. Support values given with substantiating data.
C. Preparation:
   1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
   2. Break down all costs into:
      a. Material: Delivered cost of product with taxes paid.
      b. Labor: Labor cost, excluding overhead and profit.
D. Update Schedule of Values when:
   1. Indicated by Owner/Engineer.
   2. Change of subcontractor or supplier occurs.
   3. Change of product or equipment occurs.

1.7 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
B. Change order work shall not proceed until authorized.
1.8 EQUIPMENT SUPPLIERS' INSPECTION
A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
   1. Fire Seal Systems
B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
C. Submit copies of start-up reports to the Owner/Engineer and include copies of Owner’s Operation and Maintenance Manuals.

1.9 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE
A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

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

1.11 WARRANTY
A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

1.12 MATERIAL SUBSTITUTION
A. Where several manufacturers’ names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Owner/Engineer not later than ten days prior to the bid opening.

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

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

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

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

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

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

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

B. Excavation:
   1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
   2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Owner/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
   3. Trim bottom and sides of excavations to grades required for foundations.
   4. Protect excavations against frost and freezing.
   5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
   6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
   7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
   8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Owner/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Owner/Engineer or their representative.
C. Dewatering:
1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

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

E. Fill and Backfilling:
1. No rubbish or waste material is permitted for fill or backfill.
2. Provide all necessary sand and/or CA6 for backfilling.
3. Dispose of the excess excavated earth as directed.
4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris, or earth with a high void content.
5. Backfill all trenches and excavations immediately after installing pipes or removal of forms, unless other protection is provided.
6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.
7. Lay all piping on a compacted bed of CA6 at least 3 inches deep. Backfill around pipes with CA6, 6 inch layers, and compact each layer.
8. Use sand or CA6 for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand or CA6 backfill to 6 inches above the top of the pipe.
9. Place all backfill above the sand/CA6 in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

F. Surface Restoration:
1. Where trenches are cut through graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days’ notice to the Owner/Engineer prior to:
1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard ceilings and soffits.

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

C. Above-Ceiling Final Observation
1. All work above the ceilings must be complete prior to the Owner/Engineer’s review. This includes, but is not limited to:
   a. Pipe insulation is installed and fully sealed.
   b. Pipe wall penetrations are sealed.
   c. Pipe identification and valve tags are installed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Owner/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Owner/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

3.4 PROJECT CLOSEOUT

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

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

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

3.5 OPERATION AND MAINTENANCE MANUALS

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

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

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Owner, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Owner’s/Engineer’s shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copies of all factory inspections and/or equipment startup reports.

5. Copies of warranties.

6. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

7. Dimensional drawings of equipment.

8. Capacities and utility consumption of equipment.

9. Detailed parts lists with lists of suppliers.

10. Operating procedures for each system.

11. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

12. Repair procedures for major components.

13. List of lubricants in all equipment and recommended frequency of lubrication.

14. Instruction books, cards, and manuals furnished with the equipment.

3.6 SYSTEM STARTING AND ADJUSTING

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

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

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

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

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

A. The following paragraph supplements Division 1 requirements:
   Contractor shall maintain at the job site a separate and complete set of plumbing drawings and
   specifications on which he shall clearly and permanently mark in complete detail all changes made
   to the plumbing systems.

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

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

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

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

3.8 ADJUST AND CLEAN

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

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

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

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

3.9 SPECIAL REQUIREMENTS

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

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

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

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Hangers, Supports, and Associated Anchors.
B. Sleeves and Seals.
C. Flashing and Sealing of Equipment and Pipe Stacks.
D. Cutting of Openings.
E. Escutcheon Plates and Trim.

1.2 REFERENCES
B. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
C. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices

1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS
A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

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

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Hanger Rod Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot; and smaller</td>
<td>Column #1 3/8&quot;</td>
</tr>
</tbody>
</table>

Column #1: Steel and cast iron pipe.
Column #2: Copper and plastic pipe.
B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.

2.2 PIPE AND STRUCTURAL SUPPORTS
A. General:
1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69 and 89.
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.
   a. Insulation Couplings:
      1) Insulation Coupling: Molded thermoplastic, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
      2) Horizontal Strut Mounted Insulated Pipe:
         a) Acceptable Manufacturers: Klo-Shure or equal.
3. Copper piping located in an exposed area shall use split ring standoff hangers for copper tubing. Support shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp. Use electro-galvanized or more corrosion resistant and threaded rod for floor applications. Use anchors applicable to the wall type with corrosion resistant threaded rod for wall applications.

Acceptable Products:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model/Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erico/M-Co</td>
<td>Model #456</td>
</tr>
<tr>
<td>B-Line</td>
<td>Fig. 3198HCT</td>
</tr>
<tr>
<td>Anvil</td>
<td>Fig. CT138R</td>
</tr>
<tr>
<td>Nibco/Tolco</td>
<td>Fig. 301CT</td>
</tr>
</tbody>
</table>

B. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.

2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.

3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.

4. Ferrous hot piping 2-1/2 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

Acceptable Products:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model/Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvil</td>
<td>Fig. 160, 161, 162, 163, 164, 165</td>
</tr>
<tr>
<td>Cooper/B-Line</td>
<td>Fig. 3160, 3161, 3162, 3163, 3164, 3165</td>
</tr>
<tr>
<td>Erico</td>
<td>Model 630, 631, 632, 633, 634, 635</td>
</tr>
<tr>
<td>Nibco/Tolco</td>
<td>Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4</td>
</tr>
</tbody>
</table>

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

Acceptable Products:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model/Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooper/B-Line</td>
<td>Fig. B3380 through B3384</td>
</tr>
<tr>
<td>Pipe Shields</td>
<td>A1000, A2000</td>
</tr>
</tbody>
</table>

6. Unless otherwise indicated, hangers shall be as follows:

a. Clevis Type:

   Service:  
   - Bare Metal Pipe
   - Rigid Plastic Pipe
   - Insulated Cold Pipe

Acceptable Products:

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model/Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvil</td>
<td>Fig. 260</td>
</tr>
<tr>
<td>Cooper/B-Line</td>
<td>Fig. 3100</td>
</tr>
<tr>
<td>Erico</td>
<td>Model 400</td>
</tr>
<tr>
<td>Nibco/Tolco</td>
<td>Fig. 1</td>
</tr>
</tbody>
</table>

7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.

a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
   a. **Clamp Type:**
      Service: Bare Metal Pipe
      Rigil Plastic Pipe
      Insulated Cold Pipe
      Insulated Hot Pipe - 3 inches and smaller
      1) Clamps in direct contact with copper pipe shall include plastic pipe
         insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico
         Cushion Clamp or Cooper Vibra-Clamp.
      2) Pipes subject to expansion and contraction shall have clamps
         oversized to allow limited pipe movement.

<table>
<thead>
<tr>
<th>Acceptable Products</th>
<th>Bare Steel, Plastic or Insulated Pipe</th>
<th>Bare Copper Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unistrut</td>
<td>Fig. P1100 or P2500</td>
<td></td>
</tr>
<tr>
<td>Cooper/B-Line</td>
<td>Fig. B2000 or B2400</td>
<td>Fig. BVT</td>
</tr>
<tr>
<td>Nibco/Tolco</td>
<td>Fig. A-14 or 2STR</td>
<td></td>
</tr>
</tbody>
</table>

2.3 OPENINGS IN FLOORS, WALLS AND CEILINGS

A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
B. Coordinate all openings with other Contractors.
C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Owner/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at his expense.
E. Do not cut structural members without written approval of the Owner or Structural Engineer.

2.4 SLEEVES AND LINTELS

A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor’s work in masonry walls and floors, unless specifically shown as being by others.
B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Owner or Structural Engineer.
D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1” above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Owner/Engineer’s design.
F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
G. Where pipes rise through concrete floors that are on earthen grade, provide 3/4” resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
H. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.
2.5 **ESCUTCHEON PLATES AND TRIM**

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

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

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

2.6 **PIPE PENETRATIONS**

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

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

2.7 **PIPE ANCHORS**

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

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

2.8 **FINISH**

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

**PART 3 - EXECUTION**

3.1 **PLUMBING SUPPORTS AND ANCHORS**

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

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

C. Pipe Requirements:
   1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection,
swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.

3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.

4. Piping shall not introduce strains or distortion to connected equipment.

5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.

6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.

7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.

8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

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

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

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

G. Spacing of Hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:

<table>
<thead>
<tr>
<th>Pipe Material</th>
<th>Maximum Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel (Std. Weight or Heavier – Liquid Service):</td>
<td></td>
</tr>
<tr>
<td>1-1/4&quot; &amp; under</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>1-1/4&quot; and under</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>2&quot; &amp; larger</td>
<td>12'-0&quot;</td>
</tr>
<tr>
<td>Hard Drawn Copper &amp; Brass (Liquid Service):</td>
<td></td>
</tr>
<tr>
<td>3/4&quot; and under</td>
<td>5'-0&quot;</td>
</tr>
<tr>
<td>1&quot;</td>
<td>6'-0&quot;</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
<td>7'-0&quot;</td>
</tr>
<tr>
<td>1-1/2&quot;</td>
<td>8'-0&quot;</td>
</tr>
</tbody>
</table>

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

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Identification of products installed under Division 22.

1.2 REFERENCES


PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS


2.2 MATERIALS

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

<table>
<thead>
<tr>
<th>OD of Pipe or insulation</th>
<th>Marker Length</th>
<th>Size of Letters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 1-1/4&quot;</td>
<td>8&quot;</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

Plastic tags may be used for outside diameters under 3/4".

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

C. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.

D. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

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

F. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all products per manufacturer’s recommendations.

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

C. Valves:

1. All valves (except shutoff valves at equipment) shall have numbered tags.

2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.

3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.

4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.

5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.

6. Number all tags and show the service of the pipe.
7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Owner/Engineer.

D. Pipe Markers:
1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
3. Apply markers and arrows in the following locations where clearly visible:
   a. At each valve.
   b. On each riser and each leg of each "T" joint.

E. Equipment:
1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with the text as shown in the following table regardless of which method or material is used:

<table>
<thead>
<tr>
<th>Pipe Service</th>
<th>Lettering Color</th>
<th>Background Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>NON-POTABLE WATER</td>
<td>Black</td>
<td>Yellow</td>
</tr>
<tr>
<td>FUEL TANK VENT</td>
<td>Black</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Piping Insulation.
B. Insulation Jackets.

1.2 QUALITY ASSURANCE

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

1.3 REFERENCES

B. ASTM C591 - Unfaced Preformed Rigid Cellular Polyisocyanurate Insulation.
C. ASTM E84 - Surface Burning Characteristics of Building Materials.
E. UL 723 - Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit shop drawings per Section 22 05 00. Include product description, list of materials and thickness for each service, and locations.

PART 2 - PRODUCTS

2.1 INSULATION

A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75ºF; non-combustible. All purpose, white Kraft jacket bonded to aluminum foil and reinforced with fiberglass yarn, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
B. Type E: Preformed rigid cellular polyisocyanurate insulation; ANSI/ASTM C591; maximum 'K' value of 0.19 at 75ºF; moisture resistant; suitable for -297ºF to +300ºF.

2.2 VAPOR BARRIER JACKETS

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

2.3 JACKET COVERINGS

A. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40ºF to 150ºF. 25/50 maximum flame spread/smoke developed.
PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

A. General Installation Requirements:
   1. Install materials per manufacturer's instructions, building codes and industry standards.
   2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
   3. On all insulated piping, provide at each support an insulation insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a 180° cylindrical segment the same length as metal shields. Inserts shall be a cellular glass (for all temperature ranges) or molded hydrous calcium silicate (for pipe with operating temperatures above 70°F), with a minimum compressive strength of 50 psi. Polyisocyanurate insulation with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3”75 and below, minimum 60 psi for pipe sizes 4” and above, and operate below 300°F. Factory fabricated inserts may be used. Rectangular blocks, plugs, or wood material are not acceptable. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.
   4. Neatly finish insulation at supports, protrusions, and interruptions.
   5. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.
   6. Shields shall be at least the following lengths and gauges:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Shield Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2” to 3-1/2”</td>
<td>12” long x 18 gauge</td>
</tr>
<tr>
<td>4”</td>
<td>12” long x 16 gauge</td>
</tr>
<tr>
<td>5” to 6”</td>
<td>18” long x 16 gauge</td>
</tr>
<tr>
<td>8”</td>
<td>24” long x 14 gauge</td>
</tr>
</tbody>
</table>

B. Insulated Piping Operating Below 60°F:
   1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
   2. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

C. Insulated Piping Operating Between 60°F and 140°F:
   1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140°F:
   1. Insulate fittings, valves, flanges, and strainers.
   2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
E. Exposed Piping:
1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.
3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

3.3 INSULATION

A. Type A Insulation:
1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.
4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60ºF, seal fitting covers with vapor retarder mastic in addition to tape.

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

3.4 JACKET COVER INSTALLATION

A. Plastic Covering:
1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
2. Solvent weld all joints with manufacturer recommended cement.
3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
4. Use plastic insulation covering on all exposed pipes including, but not limited to:
   a. All exposed piping below 8'-0" above floor.
5. Elastomeric piping insulation may have two coats of latex paint instead of plastic jacket.

3.5 SCHEDULE

A. Refer to attached insulation schedule.

** END OF SECTION **
<table>
<thead>
<tr>
<th>Piping System</th>
<th>Insulation Thickness per Pipe Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1”</td>
</tr>
<tr>
<td>Domestic Cold Water - Non-Potable</td>
<td>A</td>
</tr>
</tbody>
</table>

**Insulation Inserts at Hangers**  
Type E - Match Pipe Insulation Thickness

<table>
<thead>
<tr>
<th>Engine Exhaust Piping</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>From engine to muffler</td>
<td>E 4”</td>
</tr>
<tr>
<td>From muffler to discharge</td>
<td>E 4”</td>
</tr>
<tr>
<td>Drain piping from muffler to floor drain</td>
<td>E 3”</td>
</tr>
</tbody>
</table>

**SPARE**  
**SPARE**  
**SPARE**

**KEY NOTES FOR CONTRACTORS:**  
* Type E not allowed in Return Air Plenum (not 25/50 rated)  
+ Type B < 1” thickness shall be installed using multiple layers of 3/4” or 1”.
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure Gauge.
B. Pressure Gauge Accessories.

1.2 REFERENCES

A. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze bushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.
B. Acceptable Manufacturers: Ashcroft, Marsh, Marshalltown, Miljoco, Trerice, U.S. Gauge Figure 1901, Weiss, Weksler, Wika.

2.2 PRESSURE GAUGE ACCESSORIES

A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.
B. Shutoff Valve: 1/4" ball valve as specified for each piping system.
C. Pressure snubber, brass with 1/4" connections, porous metal type.

PART 3 - EXECUTION

3.1 INSTALLATION

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

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pipe and Pipe Fittings.
B. Valves.
C. Domestic Water Piping System.
D. Engine Exhaust.
E. Sanitary Drainage System.
F. Dielectric Connections.

1.2 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.
C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.
D. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

1.3 REFERENCES

A. ANSI/ASME A112.3.1 – Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above and Below Ground.
B. ANSI/ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.
C. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
D. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
E. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
F. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings.
H. ANSI/ASME Sec 9 - Welding and Brazing Qualifications.
I. ANSI/ASTM B32 - Solder Metal.
N. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
O. ASME - Boiler and Pressure Vessel Code.
Q. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
S. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
V. ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
X. ASTM B88 - Seamless Copper Water Tube.
Y. ASTM B306 - Copper Drainage Tube (DWV).
CC. ASTM D1785 - Polyvinylchloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
DD. ASTM D2661 - ABS DWV Pipe & Fittings.
EE. ASTM D2665 - PVC DWV Pipe & Fittings.
FF. ASTM D2846 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot-
and Cold-Water Distribution Systems
GG. ASTM D3033 - Type PSP (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
HH. ASTM D3034 - Type PSM (Polyvinylchloride) (PVC) Sewer Pipe and Fittings.
II. ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners
   Used for Joining Thermoplastic Pipe and Fittings.
JJ. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipes.
KK. ASTM F656 - Standard Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl
   Chloride) (PVC) Plastic Pipe and Fittings
LL. AWS A5.8 - Brazed Filler Metal.
MM. AWWA C651 - Disinfecting Water Mains.
OO. CISPI 310 - Joints for Hubless Cast Iron Sanitary Systems.
PP. FM 1680 - Couplings Used in Hubless Cast Iron Systems.
QQ. NSF - National Sanitation Foundation

1.4 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 COLD WATER - NON-POTABLE

A. Design Pressure: 175 psi.
   Maximum Design Temperature: 200°F.
B. Piping - All Sizes:
   1. Tubing: Type L hard drawn seamless copper tube, ASTM B88.
   2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
C. Shutoff Valves:
   1. Ball Valves:
      a. BA-1:
         1) 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or
            solder ends (acceptable only if rated for soldering in line with 470°F
            melting point of lead-free solder), bronze body of a copper alloy containing
            less than 15% zinc, stainless steel ball and trim, Teflon seats  and seals.
            Apollo #77C-140, Stockham #S-255-FB-UL BR1-R, Milwaukee #BA-
            400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
            NOTES:
            a) Provide extended shaft for all valves in insulated piping.
            b) Provide lock out trim for all valves opening to atmosphere installed
               in domestic water piping over 120°F, heating water piping over
               120°F, steam, condensate, boiler feed water piping, compressed
               air piping and gasoline/kerosene piping, and as indicated on the
               drawings. Solid extended shaft is not required on valves with lock
               out trim.
D. Strainers:
   1. ST-1: Bronze body, screwed ends, screwed cover, 150 psi S @ 350°F, 200 psi CWP @
      150°F. Armstrong #F4SC, Metraflex #TS, Mueller Steam Specialty Co. #351, Sarco #BT,
      Watts #777.
2.2 ENGINE EXHAUST

A. Design Pressure: 125 psi.
   Maximum Design Temperature: 1000°F
B. Piping - All Sizes:
   2. Joints: Butt welded and flanged.
   4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5.
C. Special Requirements:
   1. Provisions shall be made for manually draining condensate from the muffler and exhaust pipe.

2.3 SANITARY DRAINAGE (ABOVE GROUND)
SANITARY INDIRECT DRAINAGE (ABOVE GROUND)

A. Design Pressure: Gravity
   Maximum Design Temperature: 180°F
B. Piping - All Sizes:
   1. Pipe and Fittings: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF Certified, CISPI Trademark.
   2. Joints: Compression gasket, ASTM C564 or lead and oakum, ASTM B29.
   3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.
C. Piping - 1-1/4" through 4":
   1. Pipe: Type M hard temper seamless copper drainage tube, ASTM B306.
   2. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
   3. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.
D. Piping - 1-1/4" through 16" (Maximum Design Temperature: 140°F):
   1. Pipe: Schedule 40 rigid, unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
   2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
   3. Fittings: Unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
   4. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
   5. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.

2.4 SANITARY DRAINAGE (BELOW GROUND - INSIDE BUILDING)

A. Design Pressure: Gravity
   Maximum Design Temperature: 180°F
B. Piping - All Sizes:
   1. Pipe and Fittings: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF certified, CISPI trademark.
   3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.
C. Piping - 1-1/2" through 15":
   1. Pipe and Fittings: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888, NSF certified, CISPI trademark.
   2. Joints: Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
   3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

D. Piping - 1-1/4" through 16" (Maximum Design Temperature: 140°F):
   1. Pipe: Schedule 40 rigid, unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
   2. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
   3. Fittings: Unplasticized PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket ends for Schedule 40 pipe.
   4. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.

2.5 SANITARY DRAINAGE (BELOW GROUND - OUTSIDE OF BUILDING)

A. Design Pressure: Gravity
   Maximum Design Temperature: 160°F

B. Piping - All Sizes:
   1. Pipe and Fittings: Standard weight hub and spigot cast iron soil pipe, corrosion protective coating inside and outside, ASTM A74, NSF Certified, CISPI Trademark.
   3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

C. Piping - 1-1/2" through 15":
   1. Pipe and Fittings: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888, NSF certified, CISPI trademark.
   2. Joints: Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
   3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

** * * * * OR * * * * *

C. Piping - 1-1/2" through 15":
   1. Pipe and Fittings: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 or ASTM A888, NSF certified, CISPI trademark.
   2. Joints: Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
   3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

D. Piping - All Sizes (Maximum Design Temperature: 140°F):
   1. Pipe and Fittings: PVC pipe, Schedule 40 and SDR 26 or less with bell and spigot ends, ASTM D1785 or ASTM D3034. Cellular core piping is not acceptable.
   3. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.
   4. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.

2.6 FUEL TANK VENT PIPING

A. Design Pressure: 125 psi
   Maximum Design Temperature: 350°F

B. Piping - 2" and Under:
3. Fittings: 150 psi steam - 300 psi WOG, black malleable iron, banded, ASTM A197, ANSI B16.3.

C. Piping - 2 1/2” and Over:
2. Joints: Butt welded and flanged.
4. Flanges: 150 psi forged steel, weld neck or slip-on, ASTM A181, Grade 1, ANSI B16.5.

2.7 CONNECTIONS BETWEEN DISSIMILAR METALS

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

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

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

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

E. Screwed Joints (acceptable up to 2” size):
1. Dielectric waterway rated for 300 psi CWP and 225°F.

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

PART 3 - EXECUTION

3.1 PREPARATION

A. Install all products per manufacturer’s recommendations.
B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
C. Remove scale and dirt, on inside and outside, before assembly.
D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories.
E. Connect to equipment with flanges or unions.
F. Use only piping materials rated for the maximum temperature of the application, e.g., do not use PVC for dishwasher drainage or piping that receives boiler blowdown.
3.2 TESTING PIPING

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

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

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

3.3 CLEANING PIPING

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

B. Air Blow:
1. Blow out pipe and components with clean compressed air. Instrument air, argon, nitrogen and sulfuric acid lines shall be blown out with dry, oil free air or nitrogen gas. "Oil Free" is defined as air compressed in a centrifugal, Teflon ring, carbon ring or water pumped air compressor. Where air supply is judged to be inadequate to continually attain cleaning velocity, alternate pressurization and sudden relief procedure may be used until discharge at all blow out points is clean. Use 80-90 psig pressure unless otherwise indicated.

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

A. General Installation Requirements:
   1. Provide dielectric connections between dissimilar metals.
   2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
   3. Group piping whenever practical at common elevations.
   4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
   5. Slope water piping and arrange to drain at low points.
   6. Install bell and spigot piping with bells upstream.
   7. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
   8. Seal pipes passing through exterior walls with a wall sealer per Section 22 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
   9. All non-potable outlets shall be clearly marked with a permanently affixed laminated sign with 3/8" high lettering saying "Non-Potable Water Not for Human Consumption." Sign shall have black lettering on a yellow background.

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

C. Valves/Fittings and Accessories:
   1. Provide clearance for installation of insulation and access to valves and fittings.
   2. Provide access doors for concealed valves and fittings.
   3. Install valve stems upright or horizontal, not inverted.
   4. Provide one plug valve wrench for every ten plug valves 2" and smaller, minimum of one. Provide each plug valve 2-1/2" and larger with a wrench with set screw.

D. Underground Piping:
   1. Install buried water piping outside the building with at least 5 feet of cover. Refer to Section 22 05 00 for Excavation, Fill, Backfill and Compaction requirements
   2. As an option, the Contractor may provide factory applied protective coatings consisting of a polyethylene plastic film bonded to the pipe surface by a hot applied thermo-plastic adhesive.
      a. Acceptable Manufacturer: Republic Steel Corp. "X-Tru-Coat"
   3. Exercise care in handling, storing and laying pipe to avoid damaging factory applied coatings. If any damage occurs, repair the coating to a condition equal to the original.
   4. Field application of protective coatings to joints, fittings and to any damaged factory applied coatings shall be similar to factory applied coatings specified above and shall be done in strict accordance with recommendations of the supplier of pipe coatings.
   5. After completion of the fabrication, laying and field coating of the joints and fittings, but prior to backfilling, inspect the entire line in the presence of the Owner/Engineer's representative with an electronic holiday detector. Any defects in the protective coatings shall be repaired in accordance with requirements for original coatings.
   6. Coat flange bolts and nuts in pits and below ground at the time of installation with a corrosion protective coating.

E. Sanitary Piping:
   1. Install all sanitary piping inside the building with a slope of at least the following:
      | Pipe Size  | Minimum Slope |
      |------------|---------------|
      | 3" and under | - 0.25" per foot |
      | 4" and over  | - 0.125" per foot |
   2. Slope sanitary piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 3 feet per second.
   3. All sanitary piping shall have at least 42" of cover when leaving the building.
   4. Starter fittings with internal baffles are not permitted.

3.5 PIPE ERECTION AND LAYING

A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

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

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

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

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

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

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

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

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

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

L. Underground pipe shall be laid in dry trenches maintained free of accumulated water. Refer to Section 22 05 00 for Excavation, Fill, Backfill and Compaction requirements.

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

3.6 DRAINING AND VENTING

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

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

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

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

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

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

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

3.7 BRANCH CONNECTIONS

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

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

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

D. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:
   1. Domestic water piping above grade.
E. Further limit use of mechanically formed fittings as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be type K or L copper tubing.
   3. Permanent marking shall indicate insertion depth and orientation.
   4. Branch pipe shall conform to the inner curve of the piping main.
   5. Main must be 1" or larger.
   6. Branch must be 3/4" or larger.

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

G. Forged weld-on fittings are limited as follows:
   1. Must have at least same pressure rating as the main.
   2. Main must be 2-1/2" or larger.

3.8 JOINING OF PIPE

A. Threaded Joints:
   1. Threads shall conform to ANSI B2.1 "Pipe Threads".
   2. Ream pipe ends and remove all burrs and chips formed in cutting and threading.
   3. Protect plated pipe and valve bodies from wrench marks when making up joints.
   4. Apply thread lubricant to male threads as follows:
      Vents: Red graphite
      All Other Services: Teflon tape

B. Flanged Joints:
   1. Steel pipe flanges shall conform to ANSI B16.5 "Steel Pipe Flanges and Flanged Fittings".
      Cast iron pipe flanges shall conform to ANSI B16.1 "Cast Iron Flanged and Flanged Fittings". Steel flanges shall be raised face except when bolted to flat face cast iron flange.
   2. Bolting for services up to 500ºF shall be ASTM A307 Grade B with square head bolts and heavy hexagonal nuts conforming to ANSI B18.2.1 "Square and Hex Bolts" and B18.2.2 "Square and Hex Nuts".
   3. Set flange bolts beyond finger tightness with a torque wrench for equal tension in all bolts. Tighten bolts so those 180º apart are torqued in sequence.
   4. Gaskets for flat face flanges shall be full face type. Gaskets for raised faced flanges shall conform to requirements for "Group I Gaskets" in ANSI B16.5. Unless otherwise specified gaskets shall meet the following requirements:
      a. Gasket material and thickness approved by manufacturer for intended service, chemical compatibility, pipe system test pressure, and operating temperature range.
      b. Maximum pressure rating of at least 250 psig.
      c. Minimum temperature rating: -10°F.
      d. Maximum temperature rating of at least 170°F for water systems operating 140°F and less.

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

D. Welded Joints:
   1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless mandatory local codes take precedence.
   2. Furnish to the Owner's Representative prior to start of work certificates qualifying each welder.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.
5. Single-welded butt joints may be employed with or without the use of backing rings in all sizes. Where backing rings are not used on pumped pressurized systems, the root side of the weld shall either be chipped or ground flush with the piping wall. For services such as vents, overflows, and gravity drains, the backing ring may be eliminated, and the root of the weld need not be chipped or ground. Backing rings shall be of the material being welded.

E. Compression Gasket Joints - Sanitary Pipe:
1. Joint shall be one-piece double seal compression type gasket made specifically for joining cast iron soil pipe. Gasket shall be neoprene, permitting joint to flex as much as 5 degrees without loss of seal. Gasket shall be extra heavy weight class, conforming to ASTM C-564.

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

G. Elastomeric Gaskets (Sanitary Pipe):
1. Hub and spigot pipe joints with elastomeric gaskets shall be made in accordance with the manufacturer's installation instructions.

H. Sleeve Gaskets (No-Hub) (Sanitary Pipe):
1. Gasket shall be heavy weight class, conforming to ASTM C564.
2. The gasket shall have an internal center stop.
3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
4. Sleeve gaskets shall be installed in accordance with the manufacturer’s installation instructions.

3.9 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

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

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

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

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

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

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

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

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

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

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

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Cleanouts.
B. Floor Drains
C. Backflow Preventers.
D. Unions.
E. Dielectric Fittings (Connections Between Dissimilar Metals).
F. Air Vents.

1.2 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.3 REFERENCES

A. ANSI A112.21.1 - Floor Drains.
B. ANSI A112.6.3 - Floor and Trench Drains; The American Society of Mechanical Engineers.
C. ANSI 1011 - Hose Connection Vacuum Breakers; American Society of Sanitary Engineering.
D. ASSE 1019 - Vacuum Breaker Wall Hydrants, Freeze Resistant Automatic Draining Type; American Society of Sanitary Engineering.

1.4 SUBMITTALS

A. Submit shop drawings under provisions of Section 22 05 00.
B. Include sizes, rough-in requirements, service sizes, and finishes.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Provide cleanouts as shown and specified on the drawings as well as required by code.
B. Cleanout shall be same size as the pipe up to 6".

2.2 FLOOR DRAINS

A. Floor drains shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.
B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

2.3 BACKFLOW PREVENTERS

A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

2.4 UNIONS

A. Copper pipe - wrought copper fitting - ground joint.
B. Black Steel (Schedule 40) Pipe - malleable iron, ground joint, 150 psi, bronze to bronze seat.
C. Galvanized Steel Pipe - galvanized malleable iron, ground joint, 150 psi, bronze to bronze seat.

2.5 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

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

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

E. Screwed Joints (acceptable up to 2" size):
   1. Dielectric waterway rated for 300 psi CWP and 225°F.

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

2.6 AIR VENTS

A. Provide means for venting air at all high points in the piping system and at all other points where air may be trapped.

B. At end of main and other points where large volume of air may be trapped - Use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.

PART 3 - EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Coordinate construction to receive drains at required invert elevations.

B. Install all items per manufacturer's instructions.

C. Cleanouts:
   1. Provide cleanouts where shown on the drawings and as required by code, but in no case farther apart than 50 feet
   2. Provide cleanouts at bases of all sanitary and storm risers as shown on the drawings and as required by code.
   3. Extend cleanouts to the floor with long sweep elbows.
   4. Install a full size, two-way cleanout within 5 feet of the foundation inside or outside of building.
   5. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with graphite and linseed oil. Ensure clearance at cleanouts for rodding of drainage system.
   6. Wall cleanouts shall be installed above the flow line of the pipe they serve, but no less than 12" above the finished floor.

D. Floor Drains:
   1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain.
2. Use alternate sealing method when installing drains in existing floor slabs.
3. Coordinate sloping requirements with the architectural plans and specifications.
4. Top of floor drain grate/strainer shall not extend above the finished floor elevation.
5. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.

E. Backflow Preventer:
1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer’s instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 23 Sections. Also refer to Division 1 - General Requirements.

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

1.2 SCOPE OF WORK

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

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

C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.

D. Scope of Work:

1. Plumbing Work shall include, but is not necessarily limited to:
   a. Furnish and install all items listed in the Plumbing Material List.
   b. Furnish and install domestic water backflow preventer as required by Code.
   c. Furnish and install a complete non-potable water piping system including cold piping within the building. Insulate all piping as specified.
   d. Furnish and install a complete sanitary sewer system.
   e. Furnish and install site sanitary sewer piping and cleanouts.
   f. Furnish and install engine exhaust piping.
   g. Furnish and install fuel tank vent piping.

2. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:
   a. Furnish and install package wall mount air handling units complete with wall openings.
   b. Furnish and install all terminal heating units.

1.3 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

A. Definitions:

1. "Mechanical Contractors" refers to the following:
   a. Plumbing Contractor.
   b. Air Conditioning and Ventilating Contractor.

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

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

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

5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
   a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

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

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<thead>
<tr>
<th>Distribution/Nominal Voltage</th>
<th>Utilization Voltage</th>
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<td>120</td>
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B. General:
1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

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

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

4. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.

5. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
   a. Light fixtures.
   b. Gravity flow piping.
   c. Electrical busduct.
   d. Electrical cable trays, including access space.
   e. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:
1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
   a. Packaged Terminal Air Handling Units.

2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.

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

D. Electrical Contractor's Responsibility:
1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.

2. Installs and wires all remote control devices furnished by the Mechanical Contractor when so noted on the Electrical Drawings.

3. Provides motor control and temperature control wiring, where so noted on the drawings.

4. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.

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

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

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

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

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

E. Examination of Drawings:
   1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
   2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
   3. Scaling of the drawings is not sufficient or accurate for determining these locations.
   4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either on the drawings or in the specifications, it shall be included in this contract.

7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.

8. Where used in mechanical documents, the word “furnish” shall mean supply for use, the word “install” shall mean connect complete and ready for operation, and the word “provide” shall mean to supply for use and connect complete and ready for operation.
   a. Any item listed as furnished shall also be installed, unless otherwise noted.
   b. Any item listed as installed shall also be furnished, unless otherwise noted.

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

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

1.5 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.
   1. Submittals list:
      | Specification | Submittal Item                           |
      |---------------|-----------------------------------------|
      | 23 05 00      | Owner Training Agenda                   |
      | 23 33 00      | Motor Operated Dampers                  |
      | 23 34 23      | Power Ventilators                       |
      | 23 37 00      | Louvers                                 |
      | 23 81 13      | Packaged Terminal Air Conditioning Units |
      | 23 82 00      | Terminal Heat Transfer Equipment        |

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
   1. Transmittal: Each transmittal shall include the following:
      a. Date
      b. Project title and number
      c. Contractor’s name and address
      d. Division of work (e.g., plumbing, heating, ventilating, etc.)
      e. Description of items submitted and relevant specification number
f. Notations of deviations from the contract documents

g. Other pertinent data

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

   a. Date
   b. Project title and number
   c. Owner/Engineer
   d. Contractor and subcontractors’ names and addresses
   e. Supplier and manufacturer’s names and addresses
   f. Division of work (e.g., plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor’s review stamps

3. Composition:

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

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

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

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

5. Contractor’s Approval Stamp:

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

   b. Unstamped submittals will be rejected.

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

      1) Only approved manufacturers are used.
      2) Addenda items have been incorporated.
      3) Catalog numbers and options match those specified.
      4) Performance data matches that specified.
      5) Electrical characteristics and loads match those specified.
      6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
      7) Dimensions and service clearances are suitable for the intended location.
      8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
      9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

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

   e. The Contractor’s approval stamp is required on all submittals. Approval will indicate the Contractor’s review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
   a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
   b. The Contractor shall clearly indicate the size, finish, material, etc.
   c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
   d. All marks and identifications on the submittals shall be unambiguous.

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

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

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

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

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

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

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

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

C. Electronic Submittal Procedures:
   1. Distribution: Email submittals as attachments to all parties designated by the Owner/Engineer, unless a web-based submittal program is used.
   2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
   3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
   4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
      a. Submittal file name: 23 XX XX.description.YYYYMMDD
      b. Transmittal file name: 23 XX XX.description.YYYYMMDD
   5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.6 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:
   1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Engineer.
   2. Submit in Excel format.
   3. Support values given with substantiating data.

C. Preparation:
   1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
   2. Break down all costs into:
      a. Material: Delivered cost of product with taxes paid.
      b. Labor: Labor cost, excluding overhead and profit.

D. Update Schedule of Values when:
   1. Indicated by Owner/Engineer.
   2. Change of subcontractor or supplier occurs.
   3. Change of product or equipment occurs.
1.7 CHANGE ORDERS
A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
B. Change order work shall not proceed until authorized.

1.8 EQUIPMENT SUPPLIERS’ INSPECTION
A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
   1. Packaged terminal air conditioning units
B. Contractor shall arrange for and obtain supplier’s on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer’s instructions.
C. Submit copies of start-up reports to the Owner/Engineer and include copies of Owner’s Operation and Maintenance Manuals.

1.9 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE
A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

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

1.11 WARRANTY
A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.
1.12 MATERIAL SUBSTITUTION

A. Where several manufacturers’ names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Owner/Engineer not later than ten days prior to the bid opening.
D. This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
E. This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
F. All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

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

3.2 ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days’ notice to the Owner/Engineer prior to:
   1. Covering exterior walls, interior partitions and chases.
   2. Installing hard or suspended ceilings and soffits.
B. The Owner/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor’s schedule shall account for these reviews and show them as line items in the approved schedule.

3.3 PROJECT CLOSEOUT

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

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

3.4 OPERATION AND MAINTENANCE MANUALS

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

B. Electronic Submittal Procedures:
   1. Distribution: Email the O&M manual as attachments to all parties designated by the Owner/Engineer.
   2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
   3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
   4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
      a. O&M file name: O&M.div23.contractor.YYYYMMDD
      b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
   5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
   6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title “Operation and Maintenance Instructions"; title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
   7. All text shall be searchable.
   8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

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

3.5 INSTRUCTING THE OWNER'S REPRESENTATIVES

A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
D. The instructions shall include:
   1. Explanation of all air handling systems.
   2. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
   3. Maintenance of equipment.
   4. Description of emergency system operation.
E. The Owner/Engineer shall be notified of the time and place instructions will be given to the Owner's representatives so he or his representative can attend if desired.
F. Minimum hours of instruction for each item shall be:
   1. Packaged Terminal Air Conditioner - 1 hour
G. The Contractor shall prepare a detailed, written training agenda and submit it to the Owner/Engineer at least two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.
H. Operating Instructions:
   1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
   2. If the Contractor does not have staff that can adequately provide the required instructions he shall include in his bid an adequate amount to reimburse the Owner for the Owner/Engineer to perform these services.

3.6 SYSTEM STARTING AND ADJUSTING

A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
C. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

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

3.7 RECORD DOCUMENTS

A. The following paragraph supplements Division 1 requirements:
Contractor shall maintain at the job site a separate and complete set of mechanical drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the mechanical systems.

B. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.

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

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

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

3.8 ADJUST AND CLEAN

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

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

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

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

3.9 SPECIAL REQUIREMENTS

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

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

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

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Ductwork Insulation.
B. Insulation Jackets.

1.2 QUALITY ASSURANCE

A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer’s certificate indicating qualifications.
B. Materials: UL listed in Category HNKT; flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723.
C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

1.3 REFERENCES

C. ASTM E84 - Surface Burning Characteristics of Building Materials.
H. UL - XHEZ - Through Penetration Firestop Systems.
I. UL 263 - Full Scale External Fire Tests with Hose Stream.
J. UL 723 - Surface Burning Characteristics of Building Materials.
K. UL 1479 - Fire Tests of Through Penetrations Firestops.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both “Out of Package” and “Installed-Compressed 25%” K and R-values.

2.2 JACKETS

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.
B. Install materials after ductwork has been tested.
C. Clean surfaces for adhesives.
D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.
E. Exterior Duct Wrap - Flexible, Type A:
   1. Apply with edges tightly butted.
   2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
   3. Seal joints with adhesive backed tape.
   4. Apply so insulation conforms uniformly and firmly to duct.
   5. Provide high-density insulation inserts at trapeze duct hangers and straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
   6. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
   7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Owner/Engineer.
   8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
   9. Staples may be used, but must be covered with tape.
   10. Vapor barrier must be continuous.
   11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.

3.2 SCHEDULE

A. Refer to Section 23 31 00 for scheduling of insulation.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Galvanized Ductwork
B. Ductwork Reinforcement
C. Ductwork Sealants
D. Rectangular Ductwork

1.2 REFERENCES: Conform to all applicable requirements of the following publications:

F. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
G. ASTM A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
I. ASTM E413-87 - Classification for Rating Sound Insulation.
L. NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.
P. UL 181 - Factory-Made Air Ducts and Air Connectors.

1.3 DEFINITIONS

A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.

PART 2 - PRODUCTS

2.1 GALVANIZED DUCTWORK

A. General Requirements:
   1. Duct and reinforcement materials shall conform to ASTM A653 and A924.
   2. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
   3. Ductwork reinforcement shall be of galvanized steel.
   4. Ductwork supports shall be of galvanized or painted steel.
   5. Strap hanger shall be a minimum of 1 inch, 18 gauge galvanized steel attached to the bottom of ducts with spacing as required by SMACNA.
6. Aircraft cable and slip cable hangers are acceptable for ducts up to 18” ø. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork. Acceptable manufacturers are Gripple, Ductmate, Duro Dyne, or Owner/Engineer approved.

7. All fasteners shall be galvanized or cadmium plated.

2.2 DUCTWORK REINFORCEMENT

A. General Requirements:
   1. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
      a. Ducts must be over 18” wide.
      b. Duct dimensions must be increased 2” in one dimension (h or w) for each row of tie rods installed.
      c. Tie rods must not exceed 1/2” diameter.
      d. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

2.3 DUCTWORK SEALANTS

A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. Pressure sensitive tape used for sealing ductwork shall be minimum 2.5-inch wide, listed and marked UL 181A-P, having minimum 60 oz/inch peel adhesion to steel, and service temperature range from -20°F to +250°F.

B. Where pressure sensitive tape is called for on drawings and specifications for sealing flexible ductwork, tape shall be minimum 2.5-inch wide, UL 181 B-FX listed, and marked tape having minimum 60 oz/inch peel adhesion to steel and service temperature range from -20°F to +250°F. Acceptable manufacturers include: Venture Tape 1581A, Compac #340, Scotch Foil Tape 3326, Polyken 339.

2.4 RECTANGULAR DUCT - SINGLE WALL

A. General Requirements:
   1. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
   2. Transitions shall not exceed the angles in Figure 4-7.

B. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:
   1. All ducts shall be cross-broken or beaded.
   2. Snap lock seams are not permitted.
   3. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
      a. Type 1:
         1) **Description:** Single wall type with 22-gauge (0.029”) or heavier vanes, 3-1/4” blade spacing, and 4” to 4-1/2” radius. Vanes hemmed if recommended by runner manufacturer. Runners shall have extra-long locking tabs. C-value independently tested at below 0.26. EZ Rail II by Sheet Metal Connectors or equal.
         2) **Usage:** Limited to 3,000 fpm and vane lengths 36” and under.
b. Type 2:
   1) **Description**: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
   2) **Usage**: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

c. Type 3 (acoustical - where acoustical lagging is located or as noted on drawings):
   1) **Description**: Same as Type 2, except filled with fiberglass and with slotted or perforated inner curve. Minimum insertion loss of 9 dB at 250 Hz and 6 dB at 1 KHz.
   2) **Usage**: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

d. Turning vanes shall operate quietly. Repair or replace vanes that rattle or flutter.

e. Runners must be installed at a 45° angle. Elbows with different size inlet and outlet must be radius type.

f. Omitting every other vane is prohibited.

4. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. **Mitered elbows (with or without turning vanes) may not be substituted for radius elbows.** Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.

5. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.

6. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
   a. Apply sealant to all inside corners. Holes at corners are not acceptable.
   b. **Acceptable Manufacturers**: Ductmate Industries - 25/35/45, Nexus, Mez, or WDCI. Other manufacturers must submit test data and fabrication standards and receive Owner/Engineer’s approval before any fabrication begins.

7. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
   a. Apply sealant to all inside corners. Holes at corners are not acceptable.
   b. Flanges shall be 24-gauge minimum (not 26 gauge).
   c. **Acceptable Manufacturers**: Lockformer TDC, TDF, United McGill, or Sheet Metal Connectors. Other manufacturers must submit test data and fabrication standards and receive Owner/Engineer’s approval before any fabrication begins.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide openings in ducts for thermometers and controllers.
B. Locate ducts with space around equipment for normal operation and maintenance.
C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment.
D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
E. Repair all duct insulation tears.
F. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible.
G. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
H. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.

3.2 DUCTWORK APPLICATION SCHEDULE

<table>
<thead>
<tr>
<th>USAGE</th>
<th>MATERIAL</th>
<th>PRESSURE CLASS</th>
<th>SEAL CLASS †</th>
<th>INSULATION (Refer to Section 23 07 13 for insulation types) ±</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Exhaust Duct from Motor Operated Damper to Louver</td>
<td>Galvanized Sheet Metal</td>
<td>-1&quot;</td>
<td>A</td>
<td>2” thick Type A (R=6.0)</td>
</tr>
<tr>
<td>Outside Air Intake from Louver to Motor Operated Damper</td>
<td>Galvanized Sheet Metal</td>
<td>-2&quot;</td>
<td>A</td>
<td>2” thick Type A (R=6.0)</td>
</tr>
<tr>
<td>Transfer Air</td>
<td>Galvanized Sheet Metal</td>
<td>+1&quot;</td>
<td>A</td>
<td>None</td>
</tr>
<tr>
<td>Ductwork Accessories (Fabric Flex Connectors, Motor Operated Dampers, Equipment Flanges, etc.)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>2” thick Type A (R=6.0)</td>
</tr>
</tbody>
</table>

† Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual
± Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).

3.3 DUCTWORK SEALING

A. General Requirements:
   1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
   2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.

4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

B. For Seal Class A ducts, all transverse joints, longitudinal seams, and duct wall penetrations shall be sealed. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Motor Operated Dampers
B. Fabric Connectors.
C. Duct Access Doors.
D. Room Temperature Sensors
E. Manual Volume Dampers

1.2 REFERENCES


1.3 SUBMITTALS

A. Submit shop drawings under provisions of Section 23 05 00.
B. Submit manufacturer's installation instructions.

PART 2 - PRODUCTS

2.1 MOTOR OPERATED DAMPERS

A. Thermally Insulated Control Damper:
1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Extruded aluminum, minimum 4” deep, 0.080” minimum thickness.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6” wide, internally insulated with expanded polyurethane foam and thermally broken, with overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid aluminum or zinc plated steel shaft with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
8. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
9. Size Limits: 48” maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
10. Maximum Leakage: Class 1A at 1” w.c. pressure differential for a 24”x24” damper.
11. Maximum Pressure Drop: 0.21" for 8,000 cfm through a 24"x24" damper (2000 fpm).

2.2 FABRIC CONNECTORS

A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.
B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.
C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.
D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.
E. All corners shall be folded, sealed with mastic and stapled on 1" centers.
F. Fabric connectors shall not be painted.
G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.
H. Acceptable Materials: Durodyne MFN-4-100, Vent Fabrics, Inc. "Ventglas", or Proflex PFC3NGA.

2.3 DUCT ACCESS DOORS

A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.
B. Review locations prior to fabrication. Install access doors at motorized dampers, fan bearings, automatic controls, louvers, and other equipment requiring service inside the duct.
C. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
D. Access doors with sheet metal screw fasteners are not acceptable.
E. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.
F. Provide quantity of access doors such that two hands can fit inside ductwork to manually reset fire dampers. This will typically require one access door on the bottom and one access door on an accessible side of the duct for sizes 12x12 and smaller.

2.4 TEMPERATURE SENSORS

A. Room Temperature Sensor:
   1. Sensor Only: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range, ± 0.50°F accuracy, no setpoint adjustment or override button.

2.5 MANUAL VOLUME DAMPERS

A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
E. Provide locking quadrant regulators on single and multi-blade dampers.
F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:
   1. Install accessories in accordance with manufacturer's instructions.
   2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Owner/Engineer.
   3. Coordinate and install access doors provided by others.
   4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24” x 24”.
   5. Provide duct test holes where indicated and as required for testing and balancing purposes.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. In-Line Cabinet Fan.

1.2 QUALITY ASSURANCE

A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
B. Sound Ratings: AMCA 301, tested to AMCA 300.
C. Fabrication: Conform to AMCA 99.
D. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

1.3 REFERENCES

B. AMCA 208 - Calculation of the Fan Energy Index (FEI).
C. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
F. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

1.4 SUBMITTALS

A. Submit shop drawings per Section 23 05 00. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point (ceiling and HVLS fans are exempt from FEI submittal requirements).
B. Submit manufacturer's installation instructions.
C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

PART 2 - PRODUCTS

2.1 IN-LINE CABINET FAN

A. Fiberglass lined, sheet metal housing, arranged for in-line installation.
B. Rubber torsion motor mounts.
C. Plug type disconnect.
D. Built-in backdraft damper.
E. Centrifugal fan.
F. Provide variable speed controller if shown on the drawings.
G. Acceptable Manufacturers: ACME, Broan, Carnes, Cook, Jenco, PennBarry, Greenheck, Soler-Palau.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Louvers.
B. Grilles and Registers.

1.2 QUALITY ASSURANCE

A. Test and rate performance of air inlets and outlets per ASHRAE 70.
B. Test and rate performance of louvers per AMCA 500L-99.
C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 REFERENCES

A. AMCA 500-L-12 - Laboratory Methods of Testing Louvers for Rating.
D. SMACNA - Duct Construction Standards.

1.4 SUBMITTALS

A. Submit product data under provisions of Section 23 05 00.
B. Submit schedule of inlets and outlets indicating type, size, location, application, and noise level.
C. Review requirements of inlets and outlets as to size, finish, and type of mounting prior to submitting product data and schedules of inlets and outlets.
D. Submit manufacturer's installation instructions.

1.5 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.
B. Conform to ASHRAE 90.1.

PART 2 - PRODUCTS

2.1 LOUVERS - FIXED - ALUMINUM

A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.
B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.
C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.
D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.
E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.
F. Contractor shall provide the General Contractor with the correct sizes and locations of all louvers required in masonry walls.

G. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.

H. Louvers shall be suitable for duct connection.


2.2 GRILLES AND REGISTERS

A. Reference to a grille means an air supply or transfer device without a damper.

B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.

C. The capacity and size of the unit shall be as shown on the drawings.

D. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10\(^{-12}\) watts with a 10 dB room effect.

E. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.

F. Provide with 3/4” blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.

G. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.

H. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.


PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:

1. Install items in accordance with manufacturers’ instructions.

2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Terminal Air Conditioning Units.
B. Wall Sleeves and Louvers.
C. Controls.

1.2 REFERENCES

C. AHRI 210 - Unitary Air Conditioning Equipment.
D. AHRI 270 - Sound Rating of Outdoor Unitary Equipment.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 05 00.
B. Indicate water, drain, and electrical rough-in connections on shop drawings or product data.
C. Submit manufacturer's installation instructions.
D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

1.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Installation of wall sleeves in finished wall assembly by General Contractor.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.
B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.7 WARRANTY

A. Provide five (5) year manufacturer's warranty on all compressors. Warranty shall be for parts and labor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Bard HVAC or preapproved equal.
2.2 MANUFACTURED UNITS
A. Provide packaged, self-contained, through-the-wall air cooled terminal air conditioning units, with wall sleeve, room cabinet, electric refrigeration system, electric heating, outside air louvers, remote temperature controls.
B. Conform to ASHRAE 90.1.

2.3 CABINET
A. Cabinet: Exterior wall mounted of 20 gauge Zinc coated steel with baked enamel finish, removable front panel with concealed latches. Color selection by the Owner.
B. Discharge Grille and Access Door: Integral discharge grilles, allowing 4-way discharge air pattern, with hinged door in top of cabinet for access to controls. Integral return grille provided with 2” MERV 8 filter bracket.

2.4 WALL SLEEVES AND LOUVERS
A. Wall Sleeves: 12” inches deep, 16 gauge galvanized steel with protective mastic coating.
B. Louvers: Flush anodized aluminum. Color selected by the Architect.
C. Provide a full flow economizer section for free-cooling based on dry bulb temperature.

2.5 CHASSIS
A. Refrigeration System:
   1. Direct expansion cooling coil.
   2. Hermetically sealed scroll compressor with internal spring isolation, external isolation, permanent split capacitor motor and overload protection.
   3. Accumulator.
   4. Condenser coil and fan.
   5. Coaxial tube in tube condenser with water regulating valve.
   6. Capillary restrictor.
   7. Reversing valve.
B. Air System: Centrifugal forward curved evaporator fans with five speed permanent split capacitor motor, permanent washable filters, positive pressure ventilation damper with concealed manual operator.
C. Heating Coil: Electric.
D. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft² of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8” per foot.
E. Condenser Fan: Propeller type with separate permanent split capacitor motor.
F. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

2.6 CONTROLS
A. Control Module: Remote mounted, LCD display, adjustable thermostat with heat anticipator, off-heat-auto-cool switch, high-low fan switch, economizer control.
B. Low Ambient Lockout Control: Down to 0ºF, outdoor thermostat shall prevent compressor operation switch to reverse cycle heating on cooling mode and on heat mode.
C. Electric resistance heater shall be locked out when heating load can be met by heat pump alone, with the exception of outdoor defrost cycles.
D. Provide unit mounted outdoor air sensors and necessary programing to operate free cooling. Dry bulb operation shall be user adjustable.

2.7 PERFORMANCE

A. Refer to drawings for performance of PTAC units.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturers' instructions.
B. Coordinate installation of units with architectural and electrical work.
C. Supply units fully charged with refrigerant and filled with oil.
D. Scheduled performance is based on AHRI 210 or AHRI 240 test conditions.

**END OF SECTION**
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Electric Unit Heaters.

1.2 QUALITY ASSURANCE
   A. All electrical equipment shall have a UL label.
   B. Factory wired equipment shall conform to ANSI/NFPA 70.

1.3 REFERENCES

1.4 SUBMITTALS
   A. Submit shop drawings per Section 23 05 00.
   B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
   C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
   D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
   E. Submit manufacturers’ installation instructions.
   F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

1.5 DELIVERY, STORAGE AND HANDLING
   A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

1.6 REGULATORY REQUIREMENTS
   A. Conform to ASHRAE 90.1.

1.7 OPERATION AND MAINTENANCE DATA
   A. Submit manufacturer’s operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

PART 2 - PRODUCTS

2.1 ELECTRIC UNIT HEATERS
   A. Horizontal or vertical discharge as scheduled on the drawings.
   B. Horizontal units shall have adjustable outlet louvers.
   C. Metal sheathed fin tube electric heating elements.
   D. Casing: Heavy gauge steel with baked enamel finish.
   E. Automatic reset thermal overload wired for instantaneous pilot operation of contactor holding coil.
   F. Motors shall be totally enclosed continuous duty with built-in thermal overload protection.
   G. Provide unit mounted and wired disconnect.
H. Provide resiliently mounted fan guard/motor support.
I. Fans: Direct drive propeller type, factory balanced.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements:
1. Install all products per manufacturers’ instructions.
2. Coordinate recess sizes for recessed equipment.
3. Protect units with protective covers during construction.
4. Comb all coils to repair bent fins.

B. Unit Heater:
1. Hang unit heaters from building structure, not from piping. Mount as high as possible within manufacturer’s recommended mounting height requirements. If unit heaters cannot be installed within manufacturer’s recommended range, notify Owner/Engineer prior to mounting.

3.2 CLEANING

A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Fire Alarm and Detection Systems Section 28 31 00.

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

1.2 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

1.3 SCOPE OF WORK

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

B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make his portion of the Electrical Work a finished and working system.

C. Description of Systems shall be as follows:
   1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
   2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
   3. Grounding system.
   4. Fire alarm system.
   5. Security system.
   6. Wiring system for temperature control system as shown on the drawings.
   7. Wiring of equipment furnished by others.
   8. Removal work and/or relocation and reuse of existing systems and equipment.
   9. Telecommunications rough-in, as shown on drawings, for installation of telecommunications equipment by others under separate contract.
   10. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.

D. Work Not Included:
   1. Telecommunications cabling will be by others, in raceways and conduits furnished and installed as part of the Electrical work.
   2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

1.4 OWNER FURNISHED PRODUCTS

A. The Owner will supply the following items for installation and/or connection by this Contractor:
   1. VFD, refer to 26 29 23 for more information.

B. The following items shall be relocated, installed and/or connected by this Contractor:
   1. Communications radio (Wireless radio modem). The Owner will supply manufacturer's installation data for new equipment purchased by him for this project.

C. This Contractor shall make all electrical system connections shown on the drawings or required for fully functional units.

D. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.
1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, AND CONTROL CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:
1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
2. "Technology Contractors" refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.
3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
4. Motor Control Wiring: The wiring associated with the operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:
1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements.
4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
   a. Luminaires.
   b. Gravity flow piping, including steam and condensate.
   c. Sheet metal.
   d. Other piping.
   e. Conduits and wireway.

D. Mechanical Contractor's Responsibility:
   1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
   2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
   3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
   4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:
   1. Wiring of all devices needed to make the Temperature Control System functional.
   2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
   3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:
   1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
   2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
   3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
   4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
   5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):
   1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".
   2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.
   3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.
   4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a
coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.

5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor’s Responsibility:
1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.
2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the “Suggested Matrix of Scope Responsibility”.
3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).
4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

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

2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
   a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor’s use if the contractor signs and returns an “Electronic File Transfer” waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.
C. Drawing Requirements:
1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
   a. Scale of drawings:
      1) General plans: 1/4 Inch = 1'-0" (minimum).
      2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
      3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
      4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
      5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

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

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

B. Qualifications:
   1. Only products of reputable manufacturers as determined by the Owner/Engineer are acceptable.
   2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:
   1. Conform to all requirements of the City of Ankeny, Iowa Codes, Laws, Ordinances and other regulations having jurisdiction.
   2. If there is a discrepancy between the codes and regulations and these specifications, the Owner/Engineer shall determine the method or equipment used.
   3. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Owner/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
   4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
   5. If there is a discrepancy between manufacturer’s recommendations and these specifications, the manufacturer’s recommendations shall govern.
   6. If there are no local codes having jurisdiction, the current issue of the NEC shall be followed.

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

E. Utility Company Requirements:
   1. Secure from the private or public utility company all applicable requirements.
   2. Comply with all utility company requirements.
   3. The Owner shall make application for and pay for new electrical service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and Utility Company.
   4. Furnish the meter socket. Verify approved manufacturers and equipment with the Utility Company.
5. The Owner shall apply and pay for any changes for removal of existing electrical service by the utility company. The Contractor shall verify approved manufacturers and equipment with the Utility Company.

F. Examination of Drawings:
1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word “furnish” shall mean supply for use, the word “install” shall mean connect up complete and ready for operation, and the word “provide” shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

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

H. Field Measurements:
1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.
1.8 SUBMITTALS

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

1. Submittals list:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Submittal Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 05 73</td>
<td>Power System Study</td>
</tr>
<tr>
<td>26 09 13</td>
<td>Power Monitoring and Control System</td>
</tr>
<tr>
<td>26 09 33</td>
<td>Lighting Control System</td>
</tr>
<tr>
<td>26 22 00</td>
<td>Dry Type Transformers</td>
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<tr>
<td>26 24 16</td>
<td>Panelboards</td>
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<tr>
<td>26 24 19</td>
<td>Motor Control</td>
</tr>
<tr>
<td>26 27 26</td>
<td>Wiring Devices</td>
</tr>
<tr>
<td>26 28 21</td>
<td>Contactors</td>
</tr>
<tr>
<td>26 29 23</td>
<td>Variable Frequency Drives</td>
</tr>
<tr>
<td>26 32 13</td>
<td>Packaged Engine Generator Systems</td>
</tr>
<tr>
<td>26 36 00</td>
<td>Transfer Switch</td>
</tr>
<tr>
<td>26 43 00</td>
<td>Surge Protection Devices</td>
</tr>
<tr>
<td>26 51 19</td>
<td>LED Lighting</td>
</tr>
<tr>
<td>28 31 00</td>
<td>Fire Alarm and Detection Systems</td>
</tr>
<tr>
<td>26 95 00</td>
<td>Supervisory and Access Control</td>
</tr>
</tbody>
</table>

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

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor’s name and address
   d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Owner/Engineer
   d. Contractor and subcontractors’ names and addresses
   e. Supplier and manufacturer’s names and addresses
   f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor’s review stamps

3. Composition:
   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers’ standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials,
equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor’s Approval Stamp:
   a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Owner/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
   b. Unstamped submittals will be rejected.
   c. The Contractor’s review shall include, but not be limited to, verification of the following:
      1) Only approved manufacturers are used.
      2) Addenda items have been incorporated.
      3) Catalog numbers and options match those specified.
      4) Performance data matches that specified.
      5) Electrical characteristics and loads match those specified.
      6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
      7) Dimensions and service clearances are suitable for the intended location.
      8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
      9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
   d. The Contractor shall review, stamp and approve all subcontractors’ submittals as described above.
   e. The Contractor’s approval stamp is required on all submittals. Approval will indicate the Contractor’s review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:
   a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
   b. The Contractor shall clearly indicate the size, finish, material, etc.
   c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
   d. All marks and identifications on the submittals shall be unambiguous.

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

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

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

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

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

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

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

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

C. Electronic Submittal Procedures:
   1. Distribution: Email submittals as attachments to all parties designated by the Owner/Engineer, unless a web-based submittal program is used.
   2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
   3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not
set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. **File Names:** Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
   a. Submittal file name: 26 XX XX.description.YYYYMMDD
   b. Transmittal file name: 26 XX XX.description.YYYYMMDD

5. **File Size:** Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

### 1.9 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. **Format:**
   1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Owner/Engineer.
   2. Submit in Excel format.
   3. Support values given with substantiating data.

C. **Preparation:**
   1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
   2. Break down all costs into:
      a. Material: Delivered cost of product with taxes paid.
      b. Labor: Labor cost, excluding overhead and profit.

D. **Update Schedule of Values when:**
   1. Indicated by Owner/Engineer.
   2. Change of subcontractor or supplier occurs.
   3. Change of product or equipment occurs.

### 1.10 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

### 1.11 PRODUCT DELIVERY, STORAGE, HANDLING AND MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.

B. Keep all materials clean, dry and free from damaging environments.

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

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

### 1.12 NETWORK / INTERNET CONNECTED EQUIPMENT

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

A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.
B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Owner/Engineer.

1.14 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers’ names are given, the manufacturer for which a catalog number is given is the basis of design and establishes the quality required.
B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fit in the allocated space. The Owner/Engineer shall make the final determination of whether a product is equivalent.
C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Owner/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on his part or on the part of other Contractors whose work is affected.
E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

PART 2 - PRODUCTS

2.1 GENERAL

A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

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

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:
   1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
   2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with his work.

B. Excavation:
   1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
   2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Owner/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
   3. Trim bottom and sides of excavations to grades required for foundations.
   4. Protect excavations against frost and freezing.
   5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
   6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
   7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
   8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Owner/Engineer or their representative, and do no further work until the Owner/Engineer or their representative gives further instructions.
   9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
   10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
   11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
   12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:
   1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:
   1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
   2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Owner/Engineer.

E. Fill and Backfilling:
   1. No rubbish or waste material is permitted for fill or backfill.
   2. Furnish all necessary sand for backfilling.
   3. Dispose of the excess excavated earth as directed.
4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.

5. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.

6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.

7. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.

8. Backfill with sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.

9. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.

10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.

11. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.

2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Owner/Engineer.

3.3 OWNER/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days’ notice to the Owner/Engineer prior to:

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

B. The Owner/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor’s schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Owner/Engineer’s review. This includes, but is not limited to:
   a. All junction boxes are closed and identified in accordance with Section 26 05 53 Electrical Identification.
   b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
   c. Luminaire whips are supported above the ceiling.
   d. Conduit identification is installed in accordance with Section 26 05 53 Electrical Identification.
   e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
   f. All wall penetrations have been sealed.

2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
3. It is understood that if the Owner/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Owner/Engineer may not recommend further payments to the contractor until full access has been provided.

3.4 PROJECT CLOSEOUT

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

B. Final Jobsite Observation:
   1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
   2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Owner/Engineer so that the final observation can be scheduled.
   3. It is understood that if the Owner/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Owner/Engineer will be deducted from the Contractor’s final payment.
   4. Contractor shall notify Owner/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.

C. The following must be submitted before Owner/Engineer recommends final payment:
   1. Operation and maintenance manuals with copies of approved shop drawings.
   2. Record documents including marked-up or reproducible drawings and specifications.
   3. A report documenting the instructions given to the Owner’s representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner’s representatives.
   4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to and place in location as directed and submit receipt to Owner/Engineer.
   5. Inspection and testing report by the fire alarm system manufacturer.
   6. Start-up reports on all equipment requiring a factory installation or start-up.

3.5 OPERATION AND MAINTENANCE MANUALS

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

B. Electronic Submittal Procedures:
   1. Distribution: Email the O&M manual as attachments to all parties designated by the Owner/Engineer.
   2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
   3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
   4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
      a. O&M file name: O&M.div26.contractor.YYYYMMDD
      b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
   5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
   6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the
title “Operation and Maintenance Instructions”, title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Owner, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Owner’s/Engineer’s shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copies of all factory inspections and/or equipment startup reports.

5. Copies of warranties.

6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

7. Dimensional drawings of equipment.

8. Detailed parts lists with lists of suppliers.

9. Operating procedures for each system.

10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

11. Repair procedures for major components.

12. Replacement parts and service material requirements for each system and the frequency of service required.

13. Instruction books, cards, and manuals furnished with the equipment.

14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.

15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

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

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

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

D. The instructions shall include:

1. Maintenance of equipment.

2. Start-up procedures for all major equipment.

3. Description of emergency system operation.

E. Notify the Owner/Engineer of the time and place for the verbal instructions to the Owner’s representative so his representative can be present if desired.

F. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.

G. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner’s representatives for the electrical and specialized systems.

2. If the Contractor does not have staff that can adequately provide the required instructions, he shall include in his bid an adequate amount to reimburse the Owner for the Owner/Engineer to perform these services.
3.7 RECORD DOCUMENTS

A. The following paragraphs supplement the requirements of Division 1.
B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Owner/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Owner/Engineer's hourly rates in effect at the time of work.
D. Record changes daily and keep the marked drawings available for the Owner/Engineer's examination at any normal work time.
E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Owner/Engineer.
F. Record actual routing of conduits exceeding 2 inches.

3.8 PAINTING

A. This Contractor shall paint the following items:
B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.
C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.
D. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.
E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Owner his color preference before ordering.
F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted; provided the factory applied finish is not marred or splattered. If so, equipment shall be refinished with the same paint as was factory applied.
G. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Owner.
H. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.
I. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:
   1. **Bare Metal Surfaces** - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
   2. **Plastic Surfaces** - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

3.9 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
C. Remove all rubbish, debris, etc., accumulated during construction from the premises.
3.10 SPECIAL REQUIREMENTS

A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.

B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner’s representative prior to setting equipment.

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

3.11 SYSTEM STARTING AND ADJUSTING

A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.

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

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

3.12 FIELD QUALITY CONTROL

A. General:
   1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester’s name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
   2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
   3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
   4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
   5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than NEC Standards. Take readings between conductors, and between conductors and ground.
   6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Owner/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:
   1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Owner/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
   2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.
3. If the ground resistance value obtained is more than the value set forth in Section 26 05 26, the following shall be done to obtain the value given:
   a. Verify that all connections in the service ground system are secure.
   b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
   c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
   d. Review results with the Owner/Engineer.

4. Before final payment is made to the Contractor submit a written report to the Owner/Engineer including the following:
   a. Date of test.
   b. Number of hours since the last rain.
   c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
   d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
   e. Make, model, and calibration date of test equipment.
   f. Tabulation of measurements taken and calculations made.

C. Other Equipment:
   1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.

D. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Owner/Engineer or authority having jurisdiction deem necessary.

E. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heat within the equipment. Coordinate with Owner/Engineer to have an Owner/Engineer representative present during testing.

F. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.

G. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

** END OF SECTION **
READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION
To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.
1. Electrical panels have typed circuit identification.
2. Per Section 26 05 00, cable insulation test results have been submitted.
3. Per Section 26 05 00, ground resistance test results have been submitted.
4. Operation and Maintenance manuals have been submitted as per Section 26 05 00.
5. Bound copies of approved shop drawings have been submitted as per Section 26 05 00.
6. Report of instruction of Owner’s representative has been submitted as per Section 26 05 00.
7. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
8. Start-up reports from factory representative have been submitted as per Section 26 05 00.

Accepted by:
Prime Contractor ________________________________________________
By ____________________________________________________________
Date ___________________

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Owner/Engineer so that the final observation can be scheduled. It is understood that if the Owner/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Owner/Engineers for additional time and expenses will be deducted from the Contractor’s contract retainage prior to final payment at the completion of the job.

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PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire
B. Cabling for remote control, signal, and power limited circuits
C. Metal-clad cable (MC)

1.2 RELATED WORK

A. Section 26 05 53 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
B. NFPA 70 - National Electrical Code (NEC)
C. UL 44 - Thermoset-Insulated Wires and Cables
D. UL 83 - Thermoplastic-Insulated Wires and Cables
E. UL 854 - Service-Entrance Cables
F. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords

PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
B. Feeders and Branch Circuits Larger Than 6 AWG in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.
C. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600-volt insulation, THHN/THWN. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid or stranded conductor, unless otherwise noted on the drawings.
D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.
E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.
F. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.2 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS:

A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.
   1. Fire alarm
   2. Low voltage switching
   3. Building automation systems and control
   4. Electronic control
   5. Security
B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a
nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.3 METAL-CLAD CABLE (MC)

A. Conductors shall be copper, 600-volt insulation, THHN. Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Metal-Clad Cables, UL 1569, exterior of metal interlocked armor.

B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

C. PART 3 - EXECUTION

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings:
   1. Building wire shall be installed in raceway.
   2. Metal clad cable, Type MC, 1/2” size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires. The flexible whips shall be between 18” to 60” in length per NEC 410.116(C).

B. All Other Locations: Building wire in raceway.

C. Above Grade: All conductors installed above grade shall be type “THHN”.

D. Underground or In Slab: All conductors shall be type “THWN”.

E. Low Voltage Cable (less than 100 volts): Low voltage cable shall be installed in raceway.

3.2 CONTRACTOR CHANGES

A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.15(B)(16) (formerly 310.16 for NEC 2008 and earlier). Service entrance conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.310.15(B)(2)(7) (formerly B.310.7 for NEC 2008 and earlier).

B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.

C. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.

B. Use no wire smaller than 18 AWG for low voltage control wiring (<100 volts).

C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

D. Use no wire smaller than 8 AWG for outdoor lighting circuits.

E. The ampacity of multiple conductors in one conduit shall be derated per NEC 310. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

G. Splice only in junction or outlet boxes.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Make conductor lengths for parallel circuits equal.

J. All conductors shall be continuous in conduit from last outlet to their termination.

K. Terminate all spare conductors on terminal blocks and label the spare conductors.

L. Cables or wires shall not be laid out on the ground before pulling.

M. Cables or wires shall not be dragged over earth or paving.

N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.

P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.

D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.

E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.

F. Only nylon rope shall be permitted to pull cables into conduit and ducts.

G. Completely and thoroughly swab raceway system before installing conductors.

3.5 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Use suitable cable fittings and connectors.

C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4”=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer’s written instructions, applicable codes, the NECA’s “Standard of Installation”, recognized industry standards; and coordinated with other contractors.

D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.

E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

F. J-hook support spans shall be based on the smaller of the manufacturer’s load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.

G. Open cable shall only be installed where specifically shown on the drawings or permitted in these specifications.

3.6 WIRING CONNECTIONS AND TERMINATIONS

A. Splice and tap only in accessible junction boxes.

B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.

C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.

D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent...
of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.

F. Thoroughly clean wires before installing lugs and connectors.

G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.

I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:
   1. Facing the front and operating side of the equipment, the phase identification shall be:
      a. Left to Right - A-B-C
      b. Top to Bottom - A-B-C

J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.7 MC CABLE INSTALLATION

A. Cable shall be supported by an approved means every 4.5’ and within 12” of outlet boxes, junction boxes, cabinets, or fittings.

B. Cable may be unsupported in the following conditions:
   1. Cable is no longer than 2’ in length at terminals where flexibility is necessary.
   2. Cable is not more than 4.5’ from the last point of support for connections within an accessible ceiling to light fixtures or equipment.

C. Conductor ampacity shall be derated as required by the NEC where more than three current carrying conductors are used.

D. Each 120 and 277-volt circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for cable derating.

E. Cables shall be cut using a rotary cutter as recommended by the manufacturer to eliminate nicking and cutting of the conductors.

F. Bending radius shall comply with the requirements listed in the NEC for the type and size of cable being installed but shall not be less than 5-times the diameter of the cable in any case.

G. At cable terminations, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an insulating bushing or its equivalent protection shall be provided between the conductors and the armor.

3.8 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a “Megger”. The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.

C. Inspect wire and cable for physical damage and proper connection.

D. Torque test conductor connections and terminations to manufacturer’s recommended values.

E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

F. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.

G. Protection of wire and cable from foreign materials:
   1. It is the Contractor’s responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer’s performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
H. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment grounding system
B. Bonding system
C. Grounding electrode system

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
B. Testing Agency’s Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. Comply with UL 467 Grounding and Bonding Equipment.

1.3 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)

1.4 SUMMARY

A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section 26 05 13 "Wire and Cable".
B. Material: Copper.
C. Equipment Grounding Conductors: Insulated. Refer to Section 26 05 53 for insulation color.
D. Isolated Ground Conductors: Insulated. Refer to Section 26 05 53 for insulation color.
E. Grounding Electrode Conductors: Stranded cable.
F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
G. Copper Bonding Conductors: As follows:
   1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
   2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
   3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
   4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTOR PRODUCTS

A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
B. Connectors: Exothermic-welded type, in kit form, and selected per manufacturer’s written instructions.
C. Bolted Connectors: Bolted-pressure-type connectors.
2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.
B. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.
C. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to NFPA 70, Paragraph 52-(3), using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet (6.0 m) of 1/2" (13mm) steel reinforcing bar.

PART 3 - EXECUTION

3.1 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
   1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
   2. Make connections with clean, bare metal at points of contact.
   5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.


H. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity.

I. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.2 INSTALLATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain,
impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.

C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.

D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

E. In raceways, use insulated equipment grounding conductors.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.3 EQUIPMENT GROUNDING SYSTEM

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
   1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
   3. Flexible raceway runs, including FMC and LFMC.

D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.4 BONDING SYSTEM

A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.

B. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.

C. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

D. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.

E. Terminal Cabinets: Terminate bonding conductor on cabinet grounding terminal.

F. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

3.5 GROUNDING ELECTRODE SYSTEM

A. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.

B. Provide bonding at Utility Company’s metering equipment and pad mounted transformer.

C. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.
   1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
   2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building’s main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

F. Concrete-Encased Grounding Electrode (Ufer): Install concrete-encased grounding electrode encased in at least 2 inches (50mm) of concrete horizontally within the foundation that is in contact with the earth. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.6 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
   1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
   2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:
   3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:
   4. Testing: Perform the following field quality-control testing:
      a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
      b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
      c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
         1) Equipment Rated 500 kVA and Less: 10 ohms.
         2) Equipment Rated 500 to 1000 kVA: 5 ohms.
         3) Equipment Rated More Than 1000 kVA: 3 ohms.
         4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
         5) Manhole Grounds: 10 ohms.
      d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Owner/Engineer promptly and include recommendations to reduce ground resistance.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and equipment supports
B. Fastening hardware
C. Concrete housekeeping pads

1.2 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 COORDINATION

A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Allied Support Systems
B. Cooper B-Line
C. Erico, Inc.
D. Hilti
E. Power Fasteners
F. Orbit Industries

2.2 MATERIAL

A. Support Channel: stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.
B. Hardware: Corrosion resistant.
C. Anchorage and Structural Attachment Components:
   1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.
      a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
   2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
   3. Welding Lugs: Comply with MSS-SP-69, Type 57.
   5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings and matched to the type and size of anchor bolts and studs used.
   6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings and matched to the type and size of attachment devices used.
   7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
   8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.
D. Conduit Sleeves andLintels:
   1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor’s work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
   2. Lintels:
      a. Lintels in non-bearing masonry wall openings can be sized in accordance with the note below. Lintels that occur in existing bearing walls are to be sized according to similar conditions and spans in the new construction and lintel schedule. Bottom plate size shall be a minimum of 3/8” thick. The width of the plate shall be 3/4” less than the field verified wall thickness. The plate shall be the full length of the lintel member. Lintels are not required over openings that are 12” wide or less and at least 1 course below the top of the wall.
      b. All lintels shall have a minimum of 8” end bearing.
      c. All lintels in exterior wall construction shall be hot-dip galvanized.
      d. For all openings not otherwise detailed or scheduled, minimum lintels shall be for each 4 inch of masonry width:
         1) 0 to 2'-0" span  5/16" plate (3/4" less than wall width)
         2) 2'-0" to 4'-0" span  L 3 1/2 x 3 1/2 x 1/4
         3) 4'-0" to 6'-0" span  L4 x 3 1/2 x 5/16 (I1v)
         4) 6'-0" to 8'-0" span  L5 x 3 1/2 x 5/16 (I1v)
      e. All angles that are back to back shall be welded top and bottom 3” at 12” minimum.
   3. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Owner or Structural Engineer.
   4. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
   5. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1” above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
   6. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
   7. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
   8. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
   9. Where conduits rise through concrete floors that are on earthen grade, provide 3/4” resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
   10. Size sleeves large enough to allow expansion and contraction movement.

E. Concrete Housekeeping Pads:
   1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6” of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2” thick concrete.
   2. Bases shall extend 3” on all sides of the equipment (6” larger than factory base).
   3. Where the base is less than 12” from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
   4. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6” x 6”, W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.

D. Do not use powder-actuated anchors without specific permission.

E. Do not drill structural steel members.

F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

G. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.

H. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting.

I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

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

K. Refer to Section 26 05 33 for special conduit supporting requirements.

3.2 FINISH

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

B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Rigid metallic conduit and fittings (RMC)
B. Intermediate metallic conduit and fittings (IMC)
C. Electrical metallic tubing and fittings (EMT)
D. Flexible metallic conduit and fittings (FMC)
E. Rigid polyvinyl chloride conduit and fittings (PVC)
F. Wall and ceiling outlet boxes
G. Electrical connection
H. Pull and junction boxes
I. Accessories

1.2 RELATED WORK

A. Section 26 05 53 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
   2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
   3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
   4. ANSI C80.6 - Intermediate Metal Conduit, Zinc Coated
   5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
B. Federal Specifications (FS):
   1. A–A–50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
   2. A–A–55810 - Specification for Flexible Metal Conduit
C. NECA “Standards of Installation”
D. National Electrical Manufacturers Association (NEMA):
   1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
   2. RN 1 - Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
   3. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
E. NFPA 70 - National Electrical Code (NEC)
F. Underwriters Laboratories (UL): Applicable Listings
   1. UL 1 - Flexible Metal Conduit
   2. UL 6 - Rigid Metal Conduit
   3. UL514-B - Conduit Tubing and Cable Fittings
   4. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
   5. UL746A - Standard for Polymeric Materials – Short Term Property Evaluations
   6. UL797 - Electrical Metal Tubing
   7. UL1242 - Intermediate Metal Conduit
G. Definitions:
   1. Fittings: Conduit connection or coupling.
   2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
   3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
4. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.

5. Slab: Horizontal pour of concrete used for a floor or sub-floor.

PART 2 - PRODUCTS

2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Acceptable Manufacturers:

B. Minimum Size Galvanized Steel: 3/4 inch (19mm), unless otherwise noted.

C. Fittings and Conduit Bodies:
   1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
   2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
   3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
   4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
   5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

D. PVC Externally Coated Conduit: Compliant with NEMA RN 1; rigid galvanized steel conduit with external 40 mil PVC coating and internal 2 mil urethane coating surface. All fittings and conduit bodies shall be complete with coating. The PVC coated system shall include necessary PVC coated fittings, boxes and covers to form a complete encapsulated system. Acceptable Manufacturers: Calbond Calpipe, Robroy, T&B Ocal or approved equal.

2.2 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers: Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or approved equal.

C. Fittings and Conduit Bodies:
   1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
   2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
   3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
   4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**
   5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.
2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.
B. Acceptable Manufacturers of EMT Conduit: Allied, Calbond Calpipe, LTV, Steelduct, Wheatland Tube Co, or approved equal.
C. Fittings and Conduit Bodies:
   1. 2” Diameter or Smaller: Compression or steel set screw type of steel designed for their specific application.
   2. Larger than 2”: Compression or steel set screw type of steel designed for their specific application.

2.4 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8” flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8” FMC shall be six (6) feet.
B. Acceptable Manufacturers: American Flex, Alflex, Electri-Flex Co, or approved equal.
C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.
D. Fittings and Conduit Bodies:
   1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
   2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

2.5 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.
B. Acceptable Manufacturers: Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or approved equal.
C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.
D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.6 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, minimum of 14 gauge, with 1/2-inch male fixture studs where required.
B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.
C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast fer-alloy, or stainless steel deep type, gasketed cover, threaded hubs.
D. Outlet boxes for luminaires to be not less than 1-1/2” deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.
E. Switch outlet boxes for local light control switches shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.
F. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.7 [ECONN]: ELECTRICAL CONNECTION

A. Electrical connection to equipment and motors, sized per NEC. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

2.8 ACCESSORIES

A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control – IsoBacker Pad, SpecSeal – SSP Putty and Pads, 3M #MPP-4S or equal.

PART 3 - EXECUTION

3.1 CONDUIT INSTALLATION SCHEDULE AND SIZING

A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Owner/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the NEC shall be required.

B. The following schedule shall be adhered to unless they constitute a violation of applicable codes or are noted otherwise on the drawings. The installation of RMC conduit will be permitted in place of all conduit specified in this schedule.

<table>
<thead>
<tr>
<th>Installation Type</th>
<th>RMC</th>
<th>IMC</th>
<th>EMT</th>
<th>RTRC</th>
<th>PVC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeders: Switchboards, distribution panels, panelboards, motor control centers, etc.</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Branch Circuits: Lighting, receptacles, controls, etc.</td>
<td>X</td>
<td></td>
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<tr>
<td>Mechanical Equipment Feeders: Pumps, chillers, air handling units, etc.</td>
<td>X</td>
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<tr>
<td>Floor Mounted Equipment Feeders: Pumps, etc. (include no more than 6 feet of LFMC to pump)</td>
<td>X</td>
<td></td>
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<tr>
<td>Controls (lighting, power, building automation, etc.)</td>
<td>X</td>
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<tr>
<td>Wet and Damp Locations: (conduit, boxes, fittings, installed and equipped to prevent water entry)</td>
<td>X</td>
<td></td>
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<tr>
<td>Elevated Concrete Slabs (above grade)</td>
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<tr>
<td>Interior Locations: Concealed</td>
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<tr>
<td>Interior Locations: Exposed</td>
<td>X</td>
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</tr>
</tbody>
</table>

1. Underground / Slabs on Grade:
   a. In or Under Slabs on Grade:
      1) Within 5' from the perimeter of the building: PVC
      2) Within 5' from the perimeter of the building when passing through the perimeter of the building foundation Concrete encased PVC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.
   b. Site Conduits:
      1) Within 5' from the Perimeter of a Building Foundation: Concrete encased PVC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.
      2) 5' or Greater from the Perimeter of a Building Foundation: PVC.
      3) Under Roads, Drives, and Vehicle Traveled Ways: Schedule 40 or Schedule 80 PVC with a minimum of 3" concrete cover on all sides of conduit.
4) Reinforcing shall consist of one-half inch deformed bars spaced 12 inches on center, paralleling the ducts on bottom, with one-half inch deformed tie bars spaced twelve inches on centers.
5) Bars shall overlap 40 diameters and shall extend 5’ beyond roads, drives, traveled ways, etc.
6) Provide minimum 3” concrete cover on all sides of reinforcing.
7) Entire ductbank shall be installed on precast concrete pavers on 3’ centers.

C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to NEC. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the NEC (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

D. Minimum Conduit Size (Unless Noted Otherwise):
1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
2. Below Grade 5’ or less from Building Foundation: 3/4 inch.
4. Telecommunication Conduit: 1 inch.
5. Controls Conduit: 3/4 inch.

E. Conduit Embedded in Slabs above Grade:
1. Embedded installation NOT allowed in elevated slabs with metal composite decks nor structural pour in place slabs less than 6 inches in depth unless specifically noted or shown on drawings otherwise.
2. Maximum size 1-1/4 inch for conduits crossing each other.

F. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

A. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Owner/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.
C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):
1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3” concrete cover.
2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.
D. Conduit shall not share the same cell as structural reinforcement in masonry walls.
E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.
F. Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Owner/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
G. Contractor shall cooperate with all Contractors on the project. He shall obtain details of other Contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. The other trades involved as directed by the Owner/Engineer
shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.3 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Owner/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2” and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.

F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.

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

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the NEC requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the NEC requirements.

L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:
   1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
   2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1” of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.4 CONDUIT INSTALLATION

A. Conduit Connections:
   1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
   2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
   3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:
   1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
   2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
   3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
   4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
      a. A third bend is acceptable if:
         1) The total run is not longer than (33) feet.
         2) The conduit size is increased to the next trade size.
   5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
   6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
   7. Conduit Placement:
      1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the NEC.
      2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
      3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
      4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
      5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
      6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant.
      7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.
      8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, equal to O-Z/Gedney type EYD.
      9. Horizontal conduit routing through slabs above grade
         a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3" min. concrete cover. Conduits shall run parallel to each other and spaced at least 8" apart centerline to centerline. Secure raceways to
reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1”.

b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.

c. No conduits are allowed to be routed horizontally through slabs above grade.

10. Do not route conduits across each other in slabs on grade.

11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.

12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6” into the surface concealing the non-metallic conduit.

13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.

14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.

15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3” above finished floor (AFF).

16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4” below ceiling and as close to the wall as possible.

17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4” above finished floor (AFF) and as close to the wall as possible.

3.5 CONDUIT TERMINATIONS

A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.

B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the NEC, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6’ in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.

F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer’s recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.

G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.
3.6 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:
   1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):
   1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.
   2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Owner/Engineer prior to conduit installation to determine bend radius.

C. Conduit Elbows (vertical):
   1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (>600V) and 18 inches for secondary conduits (<600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Conduit Placement:
   1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
   2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
   3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f’c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
   4. Before the Contractor pulls any cables into the conduit he shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
   5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
   6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
   7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
   8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Drilling:
   1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
   2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

F. Raceway Seal:
   1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
   2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with “JackMoon” or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).
   a. Manufacturers: Raychem Rayflate Duct Sealing Systems RDSS
3.7 BOX INSTALLATION SCHEDULE
A. Galvanized steel boxes may be used in:
   1. Concealed interior locations above ceilings and in hollow studded partitions.
   2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8’ above the highest platform level.
   3. Direct contact with concrete except slab on grade.
B. Cast boxes shall be used in:
   1. Exterior locations.
   2. Exposed interior locations within 8’ of the highest platform level.
   3. Direct contact with earth.
   4. Direct contact with concrete in slab on grade.
   5. Wet locations.

3.8 COORDINATION OF BOX LOCATIONS
A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Owner/Engineer and General Contractor.
D. Locate and install to maintain headroom and to present a neat appearance.
E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.9 OUTLET BOX INSTALLATION
A. Do not install boxes back-to-back in walls.
   1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls.
   2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
B. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
C. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
D. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
E. Provide knockout closures for unused openings.
F. Support boxes independently of conduit.
G. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
H. Install boxes in walls without damaging wall insulation.
I. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
J. Position outlets to locate luminaires as shown on reflected ceiling drawings.
K. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.
L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.
3.10 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
B. Support pull and junction boxes independent of conduit.
C. Do not install boxes back-to-back in walls.
   1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls.
   2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

3.11 EXPOSED BOX INSTALLATION

A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
F. Wood, plastic, or fiber plugs shall not be used for fastenings.
G. Explosive devices shall not be used unless specifically allowed.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Adhesive labels, markings, nameplates, and signs
B. Wire and cable markers
C. Raceway, box, and wire identification
D. Equipment short circuit current rating (SCCR) labeling
E. Electrical equipment labeling
F. Electrical working clearance identification

1.2 REFERENCES

A. ANSI C2 - National Electrical Safety Code
B. NFPA 70 - National Electrical Code (NEC)
C. ANSI A13.1 - Standard for Pipe Identification
D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

A. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch (25mm) to 2 inches (50mm) in width.
B. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pretensioned gripping action when coiled around the cable.
C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
D. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch (5mm) minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F (10°C to 176°C). Provide ties in specified colors when used for color coding.
E. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
F. Aluminum, Wraparound Marker Bands: 1-inch (25mm) width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
G. Brass or aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch (2mm) metal tags with stamped legend, punched for fastener.
H. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.
I. Text Sizes:
   1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.
      a. Font: Normal 721 Swiss Bold
      b. Adhesive Labels: 3/16 inch (5mm) minimum text height
      c. Vinyl / Plastic Laminate Labels: 3/4" inch (19mm) minimum text height
2.2 NAMEPLATES AND SIGNS

A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch (2mm) minimum thick for signs up to 20 square inches (13 square cm), or 8 inches (200mm) in length; 1/8 inch (3mm) thick for larger sizes. Labels shall be punched for mechanical fasteners.

B. Text Sizes:
   1. The following information shall be used for text heights, fonts, and size, unless otherwise noted:
      a. Text Height: 3/8 inch (10mm) minimum

C. Baked–Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting ¼” grommets in corners.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch (10mm) galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4” grommets in corners.


F. Fasteners for Plastic-Laminated Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.

B. Install identification devices in accordance with manufacturer’s written instruction and requirements of NEC.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

D. Circuit Identification: Tag or label conductors as follows:
   1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
   2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
   3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility’s electrical installations.

E. Apply warning, caution and instruction signs as follows:
   1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
   2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch (10mm) high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
F. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.

G. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

H. Install ARC FLASH WARNING signs on all power distribution equipment per Section 26 05 73.

I. Circuits with more than 600V: Identify raceway and cable with “DANGER—HIGH VOLTAGE” in black letters 2 (50mm) inches high on orange background at 10'-0 foot (3m) intervals.
1. Entire floor area directly above conduits running beneath and within 12 inches (305mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to conduits concealed within wall.
3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

J. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches (405mm); provide a second plastic line marker to mark each edge of the trench when 16 inches (405mm) of width is exceeded. Limit line markers to direct-buried cables. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.2 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

A. Product:
1. Adhesive labels and field markings
2. Nameplates and signs

B. Identification material to be a clear, 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

C. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. “C1A #24”).

3.3 BOX LABELING

A. Products:
1. Adhesive labels and field markings

B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label, letters/numbers.

C. All junction, pull, and connection boxes shall be identified as follows:
1. For power and lighting circuits, indicate system voltage and identity of contained circuits (“120V, 1LA1-3,5,7”).
2. For other wiring, indicate system type and description of wiring (“FIRE ALARM NAC #1”).

3.4 CONDUCTOR COLOR CODING

A. Products:
1. All wire and cables shall be color coded by the manufacturer.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches (76mm) from the termination and spaced at 3- inches (76mm) centers. Tighten to a snug fit, and cut off excess length.

D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

E. Conductors shall be color coded as follows:

1. 208Y/120 Volt, 4-Wire:
   a. A-Phase – Black
   b. B-Phase – Red
   c. C-Phase – Blue
   d. Neutral – White
   e. Ground Bond – Green

2. 480Y/277 Volt, 4-Wire:
   a. A-Phase – Brown
   b. B-Phase – Orange
   c. C-Phase – Yellow
   d. Neutral – Gray
   e. Ground Bond – Green

3. Grounding Conductors:
   a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
   b. Isolated Equipment Ground Conductors: Green with colored distinctive yellow stripe along the entire length of the conductor. Isolated ground for feeders, use colored tape with alternating bands of green and yellow to provide a minimum of three bands of green and two bands of yellow.

4. Cabling for Remote Control, Signal, and Power Limited Circuits:
   a. Fire Alarm: Refer to Fire Alarm and Automatic Detection Section 28 31 00 for cable color requirements.
   b. Low Voltage Switching: Per manufacturer recommendations and code requirements.
   c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.
   d. Electronic Control: Per manufacturer recommendations and code requirements.

3.5 CONTROL EQUIPMENT IDENTIFICATION

A. Products:
   1. Nameplates and signs

B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. Labeling shall include:
   1. Equipment type and contract documents designation of equipment being served.
   2. Location of equipment being served if it is not located within sight.
   3. Voltage and phase of circuit(s).
   4. Panel and circuit number(s) serving the equipment.
   5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
   6. Date of fault current study, refer to one-line diagram

EXHAUST FAN EF-1
("LOCATED ON ROOF")
480V, 3-PHASE
FED FROM “1HA1-1”
3.6 EQUIPMENT CONNECTION IDENTIFICATION

A. Products:
   1. Nameplates and signs
B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.
C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.
D. Labeling shall include:
   1. Equipment type and contract documents designation of equipment being served
   2. Location of equipment being served if it is not located within sight.
   3. Voltage and rating of the equipment.
   4. Panel and circuit numbers(s) serving the equipment
   5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
   6. Date of fault current study; refer to one-line diagram

   UNIT HEATER UH-1
   ("LOCATED IN STORAGE ROOM 200")
   480V: 3-PHASE
   FED FROM "1HA1-1"
   22,000 AMPS AVAILABLE FAULT CURRENT
   DATE OF STUDY: 1 JAN 2017

3.7 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Products:
   1. Nameplates and signs
B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.
   1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
   2. Exterior Equipment: The identification material shall be engraved vinyl labels.
   3. Labeling shall include:
      a. Equipment type and contract documents designation of equipment.
      b. Voltage of the equipment.
      c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
      d. 

   DISTRIBUTION PANEL DP-H1
   480Y/277V
   FED FROM SWITCHBOARD “SB-1” (LOCATED IN MAIN ELEC ROOM)

C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:
   1. Nominal system voltage
   2. Maximum available fault current; refer to one-line diagram for values
   3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 26 05 73 for value.
4. Date of fault current study; refer to one-line diagram
5. Date of label

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480Y/277V
39,800 AMPS AVAILABLE FAULT CURRENT
0.07 SECOND CLEARING TIME
DATE OF STUDY: 1 JAN 2017
DATE OF LABEL: 4 JUL 2017
```

D. Arc Energy Reduction Label:
1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.
   a. Label: “This equipment is designed with a system listed below”.
   b. Applicable Systems:
      1) Arc energy reducing maintenance switch

E. Nominal System Voltage Label:
1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

F. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served (“AHU-1 LOCATED IN PENTHOUSE 1”).

G. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 05 00 for other requirements.

3.8 TRANSFORMER EQUIPMENT IDENTIFICATION

A. Products:
1. Nameplates and signs

B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.

C. Labeling shall include:
   1. Equipment type and contract documents designation of equipment
   2. Name of the upstream equipment.
   3. Voltage and rating of the equipment.
   4. Location of the upstream equipment if it is not located within sight.

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TRANSFORMER TR-15
480V: 208Y/120V 15KVA
FED FROM SWITCHBOARD “SB-1” (LOCATED IN ELEC 123)
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3.9 ELECTRICAL WORKING CLEARANCE IDENTIFICATION

A. Products:
1. Safety Yellow paint and custom stencils

B. Provide custom identification of electrical equipment working clearances in mechanical, electrical, storage, janitorial, and similar non-public areas.

C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch (76mm) wide stripes.
   1. Width of area: Width of equipment or as required by code
   2. Depth of area: Depth as required by code

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Low voltage distribution system power study.
B. Short-circuit analysis and report.
C. Selective coordination analysis and report.
D. Arc-flash hazard analysis and report.

1.2 RELATED SECTIONS

A. Section 26 05 00 - Basic Electrical Requirements
B. Section 26 24 16 - Panelboards
C. Section 26 32 13 - Packaged Engine Generator Systems
D. Section 26 36 00 - Transfer Switch

1.3 SUBMITTALS

A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified
in the related specification sections and shall bear the seal/signature of the licensed Professional
Engineer who performed the analysis.
B. The input for the power system study shall be based on the contract documents, with estimated
conductor lengths provided by the Electrical Contractor. IMEG will provide a preliminary Power
Tools for Windows project file for information, if requested.
C. Documentation of the analyses shall be submitted in a bound booklet format and shall accompany
the shop drawing submittals for equipment provided under the related work specification sections.
These shop drawings will not be reviewed without this documentation. Submit a sample arc-flash
hazard label for Owner review and approval prior to printing.
D. Power system study project model shall be submitted on electronic media for review and the
Owner's operating and maintenance records.

1.4 SCOPE

A. Provide a power system study of the electrical system shown on the plans. The study shall include
arc-fault analysis, coordination analysis and arc flash hazard analysis.
B. Contractor is required to provide a fully coordinated system for the normal and emergency electrical
system. Contractor shall provide overcurrent protective devices with the appropriate models, frame
sizes, trip units, etc. as required to provide a coordinated system.

PART 2 - PRODUCTS

2.1 Power systems study shall be completed in Power Tools for Windows (PTW) 8.0 or later version or
pre-approved equivalent program.

PART 3 - EXECUTION

3.1 SHORT-CIRCUIT ANALYSIS

A. Provide a complete short-circuit analysis from the utility service to and including the entire building
distribution as shown on the drawings.
B. Analysis shall include the entire distribution system from the point of connection to the utility power
source to the distribution panels and branch circuit panelboards.
C. Documentation shall be made in one-line diagram form showing the magnitude and location of
each calculated fault. Fault current calculations shall be made at the main bus of each switchboard,
distribution panel, and branch circuit panel. A summary of the fault currents available shall also be
submitted.
3.2 COORDINATION ANALYSIS

A. Provide a complete selective coordination analysis comparing time/current curves of the protective devices to be installed to assure coordination between main and downstream devices. Overcurrent protection devices shall be coordinated based on the maximum available fault current results of the short-circuit analysis report.

B. The analysis shall include primary protective device, secondary main switchboard device(s), switchboard branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.

C. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.
   1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.
   2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.
   3. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.
   4. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.
      a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.

D. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.

3.3 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.

C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².

D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit analysis and coordination study models. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
   1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

H. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.

I. Miscoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

J. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section.

K. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.

M. The label shall include the incident energy calculated in the analysis and the hazard category or appropriate personal protective equipment (PPE) required to perform maintenance on the system when energized. Labels shall be vinyl or laminated, with a self-adhesive backing.

N. Examples showing the minimum required information follow:

O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

3.4 ADJUSTMENTS

A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study.

B. Wherever the arc flash incident energy exceeds Arc Flash Category 2 (i.e. > 8 cal/cm²), provide options for adjusting breaker trip times, if possible, to reduce energies to Category 2 or below.

3.5 TRAINING

A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Power monitoring and control system is defined to include, but is not limited to, remote devices for monitoring, control and protection, communication interface hardware, inter-communications wiring, network software, printer, and personal computer workstations.

1.2 RELATED SECTIONS AND WORK
   A. Refer to the One-Line Diagram for rating, location and configuration.

1.3 QUALITY ASSURANCE
   A. Manufacturer: Company with three (3) years of experience in power measurements and controls.

1.4 REFERENCES
   A. ANSI C12 - Code for Electrical Metering
   B. ANSI C57.13 - Requirements for Instrument Transformers

1.5 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 26 05 00.
   B. Provide product data showing the type, size, rating, catalog number, manufacturer's names, and/or data sheets for all items to ensure compliance with these specifications. Submit operation and programming manual.
   C. Submit shop drawings of the complete layout of the entire system, showing wiring and all equipment.

1.6 REGULATORY REQUIREMENTS
   A. System: UL listed.

1.7 PROJECT RECORD DOCUMENTS
   A. Provide installation and maintenance manuals under provisions of Section 26 05 00. Include name, address and telephone number of service location.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Square D - POWERLOGIC METSEPM5560

2.2 INTERFACE TO EXTERNAL SYSTEMS
   A. Data located in the power monitoring devices and PLC registers and associated inputs/outputs shall be made available to the FMCS vendor via meters and/or programmable controller register lists. Hardware and software required by the FMCS to retrieve this data from the PMCS data highway shall be the responsibility of the FMCS vendor.

2.3 POWER MONITORING DEVICES INSTALLATION
   A. All metering devices, electronic trip units shall be installed by the equipment manufacturer for all circuits as indicated by the project drawings.
B. All control power, CT, PT, and data communications wire shall be factory wired and harnessed within the equipment enclosure. Where external circuit connections are required, terminal blocks shall be provided, and the manufacturer's drawings must clearly identify the interconnection requirements, including wire type to be used.

C. Provide control transformers, current transformers, and fused potential transformers sized as required.

D. Provide a combination fuse/shorting block. Approved Manufacturer: Elkor i-Block-600

2.4 POWER MONITORING DEVICE CHARACTERISTICS

A. [DPM]: Power Meter:
   1. The following instantaneous readings shall be monitored, displayed, and communicated by the power meter:
      a. Frequency, monthly maximum and minimum
      b. Current, per phase RMS, 3-phase average RMS, apparent RMS, peak demand (15-minute sliding window)
      c. Voltage, phase-to-phase and phase-to-neutral
      d. Power factor, per phase and 3-phase total
      e. Real power (kW), 3-phase total, peak demand, cumulative (kWH)
      f. Reactive power (kVAR), 3-phase total
      g. Total harmonic distortion (current and voltage)
   2. The current and voltage signals shall be digitally sampled at a rate high enough to provide true-RMS sensing through the 31st harmonic. All setup parameters required by the power meter shall be stored in nonvolatile memory and retained in the event of a control power interruption. The meter shall maintain, in nonvolatile memory, maximum and minimum values for each of the instantaneous values reported, as well as the time and date of the highest peak for all peak demand readings.
   3. The power meter shall be equipped with a display to provide local access to all metered quantities.
   4. Reset of the following electrical parameters shall also be allowed from the front of the display or energy meter:
      a. Peak demand current
      b. Peak demand power
      c. Energy (MWH)
      d. Reactive energy (MVARH)
   5. Waveform Capture Capability: Waveform capture shall be for three (3) cycles and initiated manually using software.
   6. The data points shall be sampled in a manner that allows the original power signals with proper magnitude and phase relationships to be reconstructed. Reconstruction of the original power signal from the stored data points shall have sufficient accuracy to allow steady-state power harmonic analysis that provides valid information on harmonic content for up to the 81st harmonic of the fundamental power frequency.
   7. The power meter shall have one (1) digital input and one (1) digital solid state output/KY pulse output.
   8. The power meter shall be provided with a six (6) digital input and two (2) digital output (relay) output accessory card.
   9. Approved Manufacturers: Schneider PM5560.

B. Electronic Trip Units:
   1. Electronic trip units shall be provided as designated on the project drawings.

2.5 SYSTEM DISPLAY UNITS

A. System display units shall be provided to display the data available from selected electronic trip units connected on the individual data transfer network.

B. The system display unit shall utilize a 4 line by 20-character, high contrast display with backlighting. The level of backlighting as well as the contrast shall be adjustable.

C. The system display shall be equipped with a screen saver feature to extend the life of the display.

D. Data shall be displayed in a logically organized manner, complete with the proper scaling and units.
E. The system display unit shall allow for easy operation by providing a keypad with large keys for operator selections. The keys shall have a raised perimeter and tactile feedback to provide a positive response, even with gloved-hand operation.

F. The keys shall be clearly marked to indicate the function and separated into meaningful groups, with display prompting to assist the user in operation.

G. Each system display unit shall be configured by the manufacturer with all necessary data. It shall be possible to change the configuration for each system display unit using the keypad provided on each display. Access to configuration functions shall be password protected to prevent unauthorized or accidental modification.

H. The system display unit shall permit the reset of the stored min-max values in the power monitoring devices. It shall also permit the reset of the accumulated energy values and the time and date stamps stored in the metering devices. These resets shall be limited to authorized persons by means of password protection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. PMCS components, including system display units, metering devices, electronic trip units, shall be installed by the manufacturer, and wired and tested in the equipment as indicated on the drawings. All control power, CT, PT, and data communications wire shall be factory wired and harnessed within the equipment enclosure.

B. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer’s drawings must clearly identify the interconnection requirements, including wire type to be used.

C. All wiring required to externally connect equipment lineups shall be installed by the Electrical Contractor.

3.2 STARTUP AND TRAINING

A. Onsite startup and training of the PMCS shall be included in the project bid. Startup shall include a complete working demonstration of the PMCS, with simulation of possible operating conditions that may be encountered.

B. Training shall include any documentation and hands-on exercises necessary to enable electrical operations personnel to assume full operating responsibility for the PMCS after completion of the training period.

C. The project bid shall include two (2) days startup assistance and three (3) days training to include two training sessions, with the second training session being two (2) months after occupancy.

D. The power monitoring manufacturer shall provide a full-time telephone technical help center for customers.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Line and low voltage standalone lighting controls
B. Time switches

1.2 RELATED SECTIONS
A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
   1. 26 51 19 - LED Lighting
   2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details

1.3 QUALITY ASSURANCE
A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
B. All components and assemblies are to be factory pre-tested prior to delivery and installation.
C. Comply with NEC as applicable to electrical wiring work.
D. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

1.4 REFERENCES
A. FS W S 896 Switch, Toggle
B. International Energy Conservation Code (IECC)
C. NEMA WD 1 - General Color Requirements for Wiring Devices
D. NFPA 70 - National Electrical Code (NEC)
E. UL Standard 916 Energy Management Equipment

1.5 SUBMITTALS
A. Submit product data under provisions of Section 26 05 00.
B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements.
C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

1.6 PROJECT RECORD DOCUMENTS
A. Submit project record documents under provisions of Section 26 05 00.
B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.
1.7 **WARRANTY**

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.

**PART 2 - PRODUCTS**

2.1 **LIGHTING CONTROLS**

A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications.

B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.

2.2 **DEVICE COLOR**

A. All switch, lighting controls, and coverplate colors shall be the same as wiring devices, unless indicated otherwise.

2.3 **COVERPLATES**

A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 05 53.

D. Plate-securing screws shall be metal with head color matching the wall plate finish.

2.4 **WALL SWITCHES**

A. Refer to Electrical Symbols List for device type.

B. [SW-1P]: Single Pole Switch:
   2. Approved Manufacturers: Hubbell HBL1221, Leviton 1221-2, Pass & Seymour PS20AC1, Cooper AH1221.

C. [SW-3W]: Three-way Switch:
   1. 120/277 volt, 20 amp. Toggle handle, side and back wired.

2.5 **TIME SWITCH**

A. [TC-1]: Astronomical time switch, 7-day, 1 channel, electronic, one SPDT 5-amp contact, LCD display, 12 or 24-hour format, minimum 100 hours carryover, UL listed.
   1. Approved Manufacturers: Paragon EC71ST, Tork DWZ100A, Intermatic ET70115C.

2.6 **CONDUCTORS AND CABLES**

A. Control Wiring:
   1. Where installed with the line-voltage wiring, control wiring shall be copper conductors not smaller than No. 16 AWG with insulation voltage rating and temperature rating equal to that of the line-voltage wiring, complying with Division 26 Section 26 05 13 "Wire and Cable."
   2. Tap conductors to switches or relays: Stranded copper conductors of 16 AWG or solid 16 or 18 AWG with insulation rating equal to that of the line-voltage wiring.
3. Tap conductors to dimming ballasts: Solid copper conductors of 18 AWG with insulation voltage rating equal to that of the line-voltage wiring and insulation temperature rating not less than 90°C.

B. Splices and Taps:
   1. Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.
B. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings.
B. All wiring shall be installed in conduit.

3.3 SUPPORT SERVICES

A. System Startup:
   1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.

B. Testing:
   1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Arrangement with Utility Company for permanent electric service
   B. Underground service entrance

1.2 RELATED SECTIONS AND WORK
   A. Refer to the One-Line Diagram for additional information.

1.3 QUALITY ASSURANCE
   B. Contact: Bruce.
   C. Install service entrance in accordance with Utility Company's rules and regulations.

1.4 SYSTEM DESCRIPTION
   A. System Voltage: 480Y/277 volts, three phase, four-wire, 60 Hertz.

PART 2 - PRODUCTS

2.1 METERING EQUIPMENT
   A. Meter: Furnished by the Utility Company.
   B. Meter Base: Furnished by the Contractor, as approved by the Utility Company. (Manufacturers: Milbank, Superior, Duncan, or Anchor).
   C. [MC-1]: Exterior Mounted Metering Cabinets: Furnished and installed by the Contractor to Utility Company's specifications. Conduit and conductors between metering cabinets and instrumentation shall be by the Contractor. Connections as required by the Utility Company.

2.2 IDENTIFICATION
   A. Provide a permanent plaque or sign denoting all services, feeders, and branch circuits supplying the building or structure and the area served by each. Install plaque or sign at each service disconnecting means.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Make arrangements with Utility Company to obtain permanent electric service to the Project.
   B. Primary distribution equipment and pad-mounted transformers shall be furnished and installed by the Utility Company.
   C. Primary conductors shall be furnished, installed, and terminated by the Utility Company. Primary conduit shall be furnished and installed by the Contractor, as shown on the drawings, to the Utility Company's requirements.
   D. Underground: Install service entrance conduits from Utility Company's pad mounted transformer to meter cabinet and building service entrance equipment. Utility Company will connect service conductors to transformer secondary lugs.
   E. Concrete Pad for Transformer: Furnished and installed by the Contractor to Utility Company's specifications.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Dry type two winding transformers [TR-#]

1.2 REFERENCES

A. NEMA - ST 1 - Specialty Transformers
B. NEMA ST 20 - Dry Type Transformers for General Applications
C. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers
D. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers
F. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
G. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

1.3 SUBMITTALS

A. Submit product data under provisions of Section 26 05 00.
B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions of Section 26 05 00.
B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.1 DRY TYPE TWO WINDING TRANSFORMERS

A. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.
B. Insulation system and average winding temperature rise for rated KVA as follows:

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Class</th>
<th>Rise (degree C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 15</td>
<td>185</td>
<td>As shown on the drawings</td>
</tr>
<tr>
<td>15 or higher</td>
<td>220</td>
<td>As shown on the drawings</td>
</tr>
</tbody>
</table>

C. Case temperature shall not exceed 40°C rise above ambient at its warmest point.
D. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.
E. **Sound Levels:** Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

<table>
<thead>
<tr>
<th>Equivalent Winding kVA Range</th>
<th>K-Factor = 1</th>
<th>K-Factor = 4</th>
<th>K-Factor = 9</th>
<th>K-Factor = 13</th>
<th>K-Factor = 20</th>
<th>Forced Air w/ Fans Running</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>40</td>
<td>40</td>
<td>67</td>
<td>45</td>
<td></td>
<td>45</td>
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<tr>
<td>9.01-30.00</td>
<td>45</td>
<td>45</td>
<td>67</td>
<td>50</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>30.01-50.00</td>
<td>45</td>
<td>48</td>
<td>67</td>
<td>50</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>50.01-150.00</td>
<td>50</td>
<td>53</td>
<td>67</td>
<td>55</td>
<td></td>
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<tr>
<td>150.01-300.00</td>
<td>55</td>
<td>58</td>
<td>67</td>
<td>57</td>
<td></td>
<td>57</td>
</tr>
<tr>
<td>300.01-500.00</td>
<td>60</td>
<td>63</td>
<td>67</td>
<td>59</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>500.01-700.00</td>
<td>62</td>
<td>65</td>
<td>67</td>
<td>61</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>700.00-1000.00</td>
<td>64</td>
<td>67</td>
<td>67</td>
<td>63</td>
<td></td>
<td>63</td>
</tr>
</tbody>
</table>

F. **Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.**

G. **Mounting:** Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

H. **Coil Conductors:** Continuous windings with terminations brazed or welded.

I. **Enclosure:** NEMA ST 20; Type 1. Provide lifting eyes or brackets.

J. **Isolate core and coil from enclosure using vibration-absorbing mounts.**

K. **Nameplate:** NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

**PART 3 - EXECUTION**

### 3.1 INSTALLATION

A. **Set transformer plumb and level.**

B. **Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.**

### 3.2 FIELD QUALITY CONTROL

A. **Check for damage and tight connections prior to energizing transformer.**

B. **Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.**

**END OF SECTION**
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Service and distribution panelboards: [MDP-#],
B. Lighting and appliance branch circuit panelboards: [Panel ‘#’]

1.2 RELATED SECTIONS AND WORK
A. Refer to the One-Line Diagram and Panel Schedules for size, rating, and configuration.

1.3 REFERENCES
A. NEMA AB 1 - Molded Case Circuit Breakers
B. NEMA PB 1 - Panelboards
C. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
D. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment
E. UL 67 - Panelboards

1.4 SUBMITTALS
A. Submit shop drawings for equipment and component devices under provisions of Section 26 05 00.
B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
C. Selective coordination study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

1.5 SPARE PARTS
A. Keys: Furnish four (4) each to the Owner.

PART 2 - PRODUCTS

2.1 RATINGS
A. Definitions:
   1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 05 53 for additional requirements.
   2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.2 MAIN AND DISTRIBUTION PANELBOARDS
A. General
   1. Approved Manufacturers:
      a. Square D QMB, I-Line
      b. General Electric Spectra ADS
      c. Siemens F2, P4
      d. Cutler Hammer PRL4, PRL5
B. Panelboards: NEMA PB 1; type as shown on the drawings.
C. Enclosure: NEMA PB 1; Type 1.
D. Provide cabinet front with hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.

G. Minimum Integrated Short Circuit Rating: 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.

H. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

I. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

J. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

K. Solid State Molded Case Circuit Breakers: Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover.

L. Arc Energy Reduction:
   1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
   2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch in the first section of the electrical equipment.

M. Suitable for use as service entrance equipment.

2.3 BRANCH CIRCUIT PANELBOARDS

A. General
   1. Approved Manufacturers:
      a. Square D NQ, NF
      b. General Electric AQ, AE
      c. Siemens P1
      d. Cutler Hammer PRL1, PRL2

B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.

J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.
B. Height: 6 feet to handle of highest device.
C. Provide filler plates for unused spaces in panelboards.
D. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

3.2 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Manual motor starters

1.2 RELATED SECTIONS AND WORK
A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

1.3 REFERENCES
A. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
B. NEMA KS 1 - Enclosed Switches

1.4 SUBMITTALS
A. Submit shop drawings and product data under provisions of Section 26 05 00.
B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.
D. Submit manufacturer's instructions under provisions of Section 26 05 00.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Section 26 05 00.
B. Store and protect products under provisions of Section 26 05 00.
C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.
D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

1.6 OPERATION AND MAINTENANCE DATA
A. Submit operation and maintenance data under provisions of Section 26 05 00.
B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

PART 2 - PRODUCTS

2.1 MANUAL MOTOR STARTERS
A. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.
B. Enclosure: NEMA ICS 6; Type 1.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

**END OF SECTION**
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Device plates and box covers
B. Modular connectors
C. Receptacles

1.2 QUALITY ASSURANCE
A. Provide similar devices from a single manufacturer.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC Article 100, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
C. Comply with the NEC.

1.3 REFERENCES
A. DSCC W-C-896F - General Specification for Electrical Power Connector
B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
C. NEMA WD 1 - General Color Requirements for Wiring Devices
D. NEMA WD 6 - Wiring Devices - Dimensional Requirements
E. NFPA 70 - National Electrical Code (NEC)
F. UL 498 - Standard for Attachment Plugs and Receptacles
G. UL 943 - Standard for Ground Fault Circuit Interrupters

1.4 SUBMITTALS
A. Submit product data under provisions of Section 26 05 00.
B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

1.5 COORDINATION
A. Receptacles for Owner Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 DEVICE COLOR
A. All switch, receptacle, outlet, and coverplate colors shall be white, unless indicated otherwise.

2.2 COVERPLATES
A. All switches, receptacles, and outlets shall be complete with the following:
   1. Unbreakable thermoplastic/thermoset plastic coverplates in finished spaces where walls are finished.
   2. #302 stainless steel coverplates in unfinished spaces for flush boxes.
B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
C. Install nameplate identification as indicated in Section 26 05 53.
D. Plate securing screws shall be metal with head color matching the wall plate finish.
2.3 RECEPTACLES

A. Refer to Electrical Symbols List for device type.

B. **[REC-DUP]**: NEMA 5-20R Duplex Receptacle:
   1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.

C. **[REC-DUP-GFI]**: NEMA 5-20R Ground Fault Duplex Receptacle:
   1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
   2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.

D. **[REC-DUP-WP]**: NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:
   1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face. Provide NEMA 3R rated while-in-use clear cover.
   2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
   3. Approved Manufacturers: Hubbell GFTR20/(RW57300) WP826, Leviton GFWT2/(5977-CL) M5979, Pass & Seymour 2097TRWR/(WIUC10-C) WIUCAST1, Cooper WRSGF20/(WIU-1) WIUMV-1.

E. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.

F. Side wired devices shall have four binding screws that are undercut for positive wire retention.

G. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.

B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.

C. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.

D. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.

E. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

F. Install devices and wall plates flush and level.

G. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 05 53 - Electrical Identification.

H. Test receptacles for proper polarity, ground continuity and compliance with requirements.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Lighting contactors
B. Enclosures

1.2 RELATED SECTIONS AND WORK
A. Refer to Lighting Contactor Schedule.

1.3 REFERENCES
A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
B. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
C. UL 508 - Industrial Control Equipment

1.4 SUBMITTALS
A. Submit shop drawings under provisions of Section 26 05 00.
B. Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.
C. Submit manufacturer's instructions under provisions of Section 26 05 00.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Schneider Electric
B. Eaton Corporation
C. G.E.
D. ASCO

2.2 [LC-#]: LIGHTING CONTACTORS
A. Contactors: NEMA ICS 2 and UL 508; electrically held.
B. Coil Operating Voltage: 120 volts, 60 Hertz.
C. Contacts: As indicated on the drawings.
D. Enclosure: ANSI/NEMA ICS 6; Type 1.
E. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction boxes: and equipment enclosures.
E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

** END OF SECTION **
SECTION IS FOR REFERENCE ONLY. VFD IS OWNER PROVIDED, CONTRACTOR INSTALLED AND WIRED.

PART 1 - GENERAL

1.1 SECTION INCLUDES
   A. Variable frequency drives [VFD-#]

1.2 RELATED SECTIONS AND WORK
   A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

1.3 REFERENCES
   A. ANSI/UL Standard 508
   B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems

1.4 SUBMITTALS
   A. Submit shop drawings and product data under provisions of Section 26 05 00.
   B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
   C. Product Data: Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
   D. Manufacturer’s Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
   E. Provide harmonic distortion analysis of total service to prove variable frequency drives proposed do not exceed the latest version of IEEE 519 voltage and current distortion limits as shown in Table 10.2 and 10.3 at the point of common coupling (PCC). The PCC shall be defined as the consumer-utility interface or primary side of the main distribution transformer.

1.5 EXTRA MATERIAL
   A. Furnish under provisions of Section 26 05 00.
   B. Provide two of each air filter.
   C. Provide three of each fuse size and type.

1.6 DELIVERY, STORAGE, AND HANDLING
   A. Deliver, store, protect and handle products to site under provisions of Section 26 05 00.
   B. Accept controllers on site in original packing. Inspect for damage.
   C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
   D. Handle in accordance with manufacturer’s written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

1.7 OPERATION AND MAINTENANCE DATA
   A. Submit operation and maintenance data under provisions of Section 26 05 00.
   B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
   C. Operation Data: Include instructions for starting and operating controllers and describe operating limits that may result in hazardous or unsafe conditions.
D. Shop Drawings: For each VFD.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. UL listing for series rating of overcurrent protective devices in combination controllers.
      e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
   2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS: Refer to Variable Frequency Drive Schedule.

2.2 DESCRIPTION

A. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC squirrel cage motors. The controller shall be suitable for use with standard NEMA B squirrel cage 1.15 service factor induction motors without requiring any modifications to the motor or the drive.

B. Controller shall have sufficient capacity to provide speed control of the motors shown or noted throughout the specified environmental operating conditions.

C. Controller shall have the functional components listed below:
   1. Door interlocked input circuit breaker/fused switch.
   2. Input rectifier section to supply fixed DC bus voltage.
   4. DC bus capacitors.
   5. Control transformer.
   6. Separate terminal blocks for power and control wiring.
   7. Terminal block for operator controls.
   8. Sine weighted PWM generating inverter section.

2.3 RATINGS

A. Rated Input Voltage: Refer to Variable Frequency Drive Schedule.
B. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule.
C. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
D. Operating Ambient: 0°C to 40°C.
E. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
F. Minimum Elevation without Derating: 3300 feet.
G. Minimum Efficiency at Full Load: 96 percent.
H. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
I. Starting Torque: 100 percent of rated torque or as indicated.
J. Speed Regulation: Plus or minus 1 percent with no motor derating.

2.4 DESIGN

A. Pulse Width Modulated (PWM) Variable Frequency Drives:
   1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section.
   2. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz. If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.
3. All controllers supplied with semi-conductors capable of switching at less than 8,000 Hertz shall be supplied with a motor acoustic noise reduction filter.

4. Pulse width modulated (PWM) drives shall be supplied with drive input harmonic filter to reduce the total harmonic distortion to less than the IEEE519-1992 limits at the utility service entrance.

5. Drives that are located beyond the manufacturer’s recommended maximum distance from the motor shall be provided with dV/dt (long lead) filters.

B. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.

C. Drive shall restart after power loss and under-voltage fault. The minimum number of restart attempts required shall be three, field adjustable.

D. The drive shall allow unlimited switching of the output without damage to the drive or motor.

2.5 PRODUCT FEATURES

A. Display: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current.

B. Protection:
   1. Input transient protection by means of surge suppressors.
   2. Snubber networks to protect against malfunctions due to system transients,
   3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
   4. Motor thermal overload relay(s) adjustable and capable of NEMA Class 10 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
   5. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   6. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
   9. Short-circuit protection (fuses or circuit breaker).
   10. Motor overtemperature fault.

C. Acceleration Rate Adjustment: 0.5 - 30 seconds.

D. Deceleration Rate Adjustment: 1 - 30 seconds.

E. Minimum Adjustment Range for the Lower Output Frequency shall be: 0 to 40 Hertz.

F. Minimum Adjustment Range for the Upper Output Frequency Range shall be: 40 to 90 Hertz.

G. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hz.

H. Provide MANUAL-OFF-AUTOMATIC selector switch and manual speed control in display mounted on the front of the enclosure.

I. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.

J. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.

K. Provide adjustable skip frequencies on the drive output (minimum of three ranges).

L. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

M. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
   1. Power on.
   2. Run.
   3. Overvoltage.
4. Line fault.
5. Overcurrent.


R. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
   1. Output frequency (Hz).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (VDC).
   9. Set-point frequency (Hz).
   10. Motor output voltage (V).

S. Control Signal Interface:
   1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
      a. 0 to 10-V dc.
      b. 0-20 or 4-20 mA.
      c. Potentiometer using up/down digital inputs.
      d. Fixed frequencies using digital inputs.
      e. RS485.
      f. Keypad display for local hand operation.
   3. Output Signal Interface:
      a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
         1) Output frequency (Hz).
         2) Output current (load).
         3) DC-link voltage (VDC).
         4) Motor torque (percent).
         5) Motor speed (rpm).
         6) Set-point frequency (Hz).
   4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
      a. Motor running.
      b. Set-point speed reached.
      c. Fault and warning indication (overtemperature or overcurrent).
      d. PID high- or low-speed limits reached.

T. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 09 00. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.

U. Control:
   1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door.
   2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
   3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.
4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.

5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass.

6. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.

2.6 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. All VFD supplied for fans shall have dynamic or DC injection braking capability to provide a means of rapid deceleration of the AC motor in not more than one (1) minute. Adjust controls to stop the motor within 30 seconds.

C. All high inertia loads that cannot be stopped in 30 seconds with the VFD dynamic braking or DC injection braking shall be provided with a chopper module and dynamic braking resistor to stop the motor within 30 seconds.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:
   1. Output frequency (Hz).
   2. Set-point frequency (Hz).
   4. DC-link voltage (VDC).
   5. Motor torque (percent).
   7. Motor output voltage (V).

F. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

G. Fabrication:
   1. Enclosure: NEMA 250, Type 1.
   2. Finish: Manufacturer's standard enamel.

H. Forced Ventilation:
   1. Inlet filter, outlet filter.
   2. Blower fan sized to maintain VFD at rated operating temperatures for ambient conditions of enclosure location.

PART 3 - EXECUTION

3.1 FACTORY TESTING

A. The VFD manufacturer shall provide certification that heat test has been completed.

B. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.

3.2 INSTALLATION

A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.

B. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.

C. Provide engraved phenolic nameplates under the provisions of Section 26 05 53.

D. Connections: All conduit connections to the VFD shall be by flexible conduit.

E. Input, output, and control wiring shall each be run in separate conduits.
F. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.

3.3 STARTUP AND COMMISSIONING

A. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.

B. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.

C. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.


** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged engine generator system
B. Exhaust silencer and fittings
C. Fuel fittings and day tank
D. Remote annunciator panel
E. Battery and charger

1.2 REFERENCES

A. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)
B. ANSI/NEMA AB 1 - Molded Case Circuit Breakers
C. ANSI/NEMA MG 1 - Motors and Generators
D. NFPA 37 - Installation and Use of Stationary Combustion Engines and Gas Turbines
E. NFPA 70 - National Electrical Code (NEC)
F. NFPA 110 - Standard for Emergency and Standby Power Systems
G. Environmental Protection Agency EPA Emission Standards for Compressed Ignition Engines
H. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at property boundaries due to sound emitted by the generator set, its components and the operation thereof.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00.
B. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
C. Submit product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.
D. Submit certificates for compliance with EPA Emissions Standards for Compressed Ignition Engines.
E. Submit manufacturer's installation instructions under provisions of Section 26 05 00.

1.4 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Section 26 05 00.
B. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal toolbox.
C. Provide two additional sets of each fuel, oil, and air filter element required for the engine generator system. Provide additional fuel polishing filters for one year of operation.
D. Provide one fuse for every type and rating used.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.
B. Store and protect products under provisions of Section 26 05 00.
C. Accept packaged engine generator set and accessories on site in crates and verify damage.
D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.
1.6 SYSTEM DESCRIPTION
A. Engine generator system to provide source of emergency and standby power.
B. System Capacity: As shown on one-line diagram, at an elevation of 1,000 feet above sea level, and ambient temperature between -20°F and 110°F; standby rating using engine-mounted radiator.

1.7 COORDINATION DRAWINGS
A. Reference Coordination Drawings article in Section 26 05 00 for required generator electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings. Show generator, fuel system components, battery system components, and exhaust system in 1/4" scale plan of room.

1.8 PROJECT RECORD DOCUMENTS
A. Submit record documents under provisions of Section 26 05 00.
B. Accurately record location of engine generator and mechanical and electrical connections.

1.9 OPERATION AND MAINTENANCE DATA
A. Submit operation and maintenance data under provisions of Section 26 05 00.
B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.10 QUALIFICATIONS
A. Manufacturer: Company specializing in packaged engine generator system with minimum five (5) years documented experience.
B. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 50 miles of the project site.

1.11 WARRANTY
A. Provide a ten (10) year warranty under provisions of Section 26 05 00.

1.12 MAINTENANCE SERVICE
A. Furnish service and maintenance of packaged engine generator system for one (1) year from Date of Substantial Completion. Maintenance service shall be performed by skilled employees of manufacturer’s designated service organization. Include quarterly exercising, and routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts, supplies, and labor.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Caterpillar

2.2 [GEN-#]: PACKAGED ENGINE-GENERATOR SET
A. Packaged engine-generator set shall be a coordinated assembly of compatible components.
B. Safety Standard: Comply with ASME B15.1 and UL 2200.
C. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer’s name and address, model and serial number, and component rating in integrated set and as required by the contract documents.
D. Fabricate engine-generator set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.

E. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the generator-set center of gravity.

F. Maximum Dimensions: 156"L x 54"W x 86.7"H.

2.3 ENGINE

A. Type: Water-cooled in-line or V-type, compression ignition diesel electric ignition internal combustion engine.

B. Rating: Sufficient to operate at 100 percent load for two hours at specified elevation and ambient limits.

C. Fuel: Appropriate for use of No. 2 fuel oil.

D. Engine Speed: 1800 RPM.

E. Governor: Isochronous type with speed sensing.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

G. Frequency Response:
   1. Steady State Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
   2. Transient Response: Less than 5 percent for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady state operating band within 5 seconds.


I. Fuel Supply System:
   1. Base-Mounted Fuel Tank: UL 142 listed fuel tank. Integral rupture basin with leak detection. The tank shall include structural steel supports for top mounted engine generator set. Furnish complete with flexible fuel line connectors lockable cover, and analog level gauge. Furnish complete with float switches to indicate 25% fuel level. The footprint of the base-mounted fuel tank shall not exceed the footprint of the generator frame for interior applications or the footprint of the enclosure for exterior installations.

J. Lubrication System: Engine or skid mounted filter and strainer, thermostatic control valve capable of full flow and designed to be fail safe, and crankcase drain arranged for gravity drainage with siphon or pump.

K. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F, and suitable for operation on 208-1Ø volts AC. The minimum wattage of the heater shall be as recommended by the manufacturer.

L. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine and integral engine-driven coolant pump.
   1. Fan and Core: Nonferrous-metal construction sized to contain expansion of total system. Blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator Airflow Restriction: 0.5 inches of water, maximum.
   2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosive additives.
   3. Provide expansion tank with gage glass and petcock, and self-contained, thermostatic-control temperature control valve.

M. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer’s instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel. Provide the following accessories:
   1. Battery: Voltage to match starter with capacity for three cranking cycles without recharge. Provide with battery cables and acid resistant battery tray.
   2. Battery-Charging Alternator: Factory mounted on engine with solid state voltage regulation.
   3. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.
4. **[BC-#]**: Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.

N. Exhaust System: Critical type silencer (85 dBA max at 10 feet), side inlet with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. Silencer shall include a threaded opening for connection of ¾" drain line. Opening shall be flush on inside of silencer.

O. The packaged engine generator shall comply with the current Environmental Protection Agency EPA Emissions standards.

P. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine-generator control panel.

Q. Mounting: Provide unit with suitable spring-type vibration isolators.

### 2.4 GENERATOR

**A.** Generator: ANSI/NEMA MG 1; three phase, re-connectible brushless synchronous generator with brushless exciter and PMG alternator excitation.

**B.** Rating: As indicated on the drawings, at 0.8 power factor, 60 Hertz at RPM to match engine rating.

**C.** Insulation: ANSI/NEMA MG 1, Class H.

**D.** Temperature Rise: 80°C continuous.

**E.** Enclosure: ANSI/NEMA MG 1; open drip-proof.

**F.** Voltage Regulation:
1. The maximum instantaneous voltage dip (IVD) shall be 30 percent.
2. Include solid-state type voltage regulator, separate from exciter to match engine and generator characteristics, with voltage regulation ±1 percent from no load to full load. Include manual controls to adjust voltage drop ±5 percent voltage level, and voltage gain.

**G.** Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

**H.** Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

### 2.5 CONTROLS AND INDICATION

**A.** Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

**B.** Ground Fault: Provide ground fault sensing at the generator. The sensor shall be located ahead of the generator service disconnect. Provide a ground fault indication on the engine-generator control panel. Provide an instruction nameplate at the control panel.

1. Instruction nameplate: Provide operational instructions for a ground fault indication as approved by the local Authority Having Jurisdiction.

**C.** **[GCP-#]**: Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:

1. Alarm indication as required by NFPA 110.
2. AC frequency meter.
3. AC output voltmeter with phase selector switch.
4. AC output ammeter with phase selector switch.
5. Output voltage adjustment.
6. DC voltmeter (alternator battery charging).
7. Engine start/stop selector switch.
8. Engine running time meter.
9. Oil pressure gauge.
10. Engine coolant temperature gauge.
11. Shut down devices for overspeed, coolant high-temperature, coolant low-level, and oil low-pressure.
14. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
17. Generator control and start signal failure.

2.6 ACCESSORIES

A. Generator Circuit Breaker: Molded or insulated case, service-rated thermal-magnetic electronic trip type; 100% rated breaker complying with NEMA AB1 and UL 489. The disconnect shall simultaneously open all associated ungrounded conductors and be lockable in the open position.
   1. Tripping Characteristic: Designed specifically for generator protection.
   2. Trip Rating: Matched to generator rating.
   3. Shunt Trip: Connected to trip breaker when generator is shut down by other protective devices.
   4. Mounting: Provide freestanding enclosure or mount integrally with control and monitoring panel.
   5. The disconnecting means shall also shut down the prime mover, disable all start control circuits, and be configured with a mechanical reset.
   6. Arc Energy Reduction: Provide and arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy system shall be provided for overcurrent protection devices rated 1,200 amps or larger.

B. [EPO]: Remote Manual Stop Station (Emergency Power Off EPO): Provide a remote manual stop station with weather proof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable cover/lens to access mushroom button, 120-volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator annunciator panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work and field dimensions are as shown on the drawings.
B. Verify that required utilities are available in proper location and ready for use.
C. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Install remote manual stop station in location shown on plans. Provide 120 Volt power and wiring in conduit as required. Coordinate installation with the manufacturer approved shop drawings and wiring diagrams. The remote manual stop station shall shunt trip the generator mounted circuit breaker and signal the engine prime mover to stop.
C. The A-B-C phase rotation of the generator source shall match the A-B-C phase rotation of the utility source. The Contractor shall verify the generator and utility phase rotation match to prevent three phase motors and similar loads from operating backwards while being served by the generator.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 05 00 and in compliance with NFPA 110 requirements.
B. Provide portable test bank for full load test, if required. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.
C. Fill fuel tank prior to start of test.
D. The on-site installation test shall be conducted as follows:
   1. With the prime mover in a “cold start” condition and the emergency load at standard operating level, a primary power failure shall be initiated by opening all switches or breakers supplying the primary power to the building or facility.
2. The test load shall be that load that is served by the Emergency Power Supply System (EPSS).
3. The time delay on start shall be observed and recorded.
4. The cranking time until the prime mover starts and runs shall be observed and recorded.
5. The time taken to reach operating speed shall be observed and recorded.
6. The voltage and frequency overshoot shall be recorded.
7. The time delay on transfer to emergency power for each switch shall be recorded. Life safety and critical branch transfer switches must transfer within 10 seconds.
8. The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.
9. The voltage, frequency, and amperes shall be recorded.
10. The prime mover oil pressure and water temperature shall be recorded, where applicable.
11. The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter.
12. When primary power is returned to the building or facility, the time delay on retransfer to primary for each switch with a minimum setting of 5 minutes shall be recorded.
13. The time delay on the prime mover cool down period and shutdown shall be recorded.
14. Allow prime mover to cool for 5 minutes.
15. A load shall be applied for 4 hours total. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate rating of the Emergency Power Supply (EPS), less applicable derating factors for site conditions. Observe and record load changes and the resultant effect on voltage and frequency.
16. The full load test shall be initiated immediately after the cooling time has expired by any method that starts the prime mover and, immediately upon reaching rated rpm, picks up 100 percent of the nameplate kW rating on one step, less applicable derating factors for site conditions.
17. During test, record the following at 5-minute intervals for the first 15 minutes and every 15 minutes for the rest of the test:
   a. Kilowatts
   b. Amperes
   c. Voltage
   d. Frequency
   e. Coolant temperature
   f. Enclosure temperature (interior)
   g. Oil pressure
   h. Engine exhaust temperature
   i. Engine inlet temperature
   j. Oil Temperature
   k. Battery charge rate
18. Upon completion of the test and after a cool down period, the crank/rest cycle shall be tested.
   a. Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.
   b. The control switch shall be set at “run” to cause the prime mover to crank.
   c. The complete crank/rest cycle shall be observed and recorded.
19. Test alarm and shutdown circuits by simulating conditions.

E. Contractor shall fill fuel tanks upon completion of test.
F. Testing documentation shall be submitted to the Owner/Engineer for review and approval.
G. Generator testing worksheets are included with this specification section.

3.4 MANUFACTURER’S FIELD SERVICES
A. Prepare, start, test, and adjust systems under provisions of Section 26 05 00.

3.5 ADJUSTING
A. Adjust generator output voltage and engine speed.
3.6 CLEANING

A. Clean work under provisions of Section 26 05 00.
B. Clean engine and generator surfaces. Replace oil and fuel filters.

3.7 DEMONSTRATION

A. Provide systems demonstration. Coordinate the demonstration schedule with the Owner and Owner/Engineer.
B. Describe loads connected to emergency and standby systems and restrictions for future load additions.
C. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

** END OF SECTION **
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PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Automatic transfer switch [ATS-#]

1.2 RELATED SECTIONS AND WORK

A. Refer to the Transfer Switch Schedule for rating and configuration.

1.3 QUALITY ASSURANCE

A. Manufacturer: Company specializing in automatic transfer equipment with three (3) years documented experience.

1.4 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control and Systems
B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies
C. NEMA ICS 2-447 - AC Automatic Transfer Switches
D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
E. UL 1008 - Standard for Automatic Transfer Switches

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00.
B. Submit product data for transfer switches showing overall dimensions, electrical connections, electrical ratings, and environmental requirements.
C. Submit manufacturer’s installation instructions under provisions of Section 26 05 00.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 05 00.
B. Include instructions for operating equipment.
C. Include instructions for operating equipment under emergency conditions when engine generator is running.
D. Identify operating limits which may result in hazardous or unsafe conditions.
E. Document ratings of equipment and each major component.
F. Include routine preventive maintenance and lubrication schedule.
G. List special tools, maintenance materials, and replacement parts.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for emergency and standby electrical systems.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. As scheduled on the drawings.

2.2 AUTOMATIC TRANSFER SWITCH

A. Description: NEMA ICS 2; automatic transfer switch.
B. Configuration: Electrically-operated, mechanically-held transfer switch.
C. Control panel shall be micro-processor based.
2.3 SERVICE CONDITIONS

A. Service Conditions: NEMA ICS 1.

2.4 RATINGS

A. Refer to the one-line diagrams for the available interrupting capacity (AIC) of the transfer switch. The transfer switch shall be series rated with the equipment feeding the transfer switch. The series rating shall be the larger of the two AIC values when the AIC rating of the equipment feeding the normal and emergency sides of the transfer switch is not equal.

B. Series rating with upstream devices shall be allowed per UL-1008.

2.5 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.

E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

2.6 ENCLOSURE

A. Enclosure: NEMA ICS 6; Type 1.

2.7 ACCESSORIES

A. Load Shed:
   1. The controller shall be capable of being programmed to automatically shed the connected load from the generator in the event of a user configurable under-frequency, under-voltage or overload condition. Under-frequency shedding shall occur if generator is less than 58Hz for greater than 3 seconds or less than 50 Hz for greater than 0.5 seconds.
   2. Switch shall be configurable to pick up an output status relay upon activation of the auto load shed feature. Output shall be usable to trip/isolate downstream loads in the event of an overload.
   3. Reset of the auto load shed function shall be via operator reset on display, remote reset contact input, or via network signal.

B. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.

C. Test Switch: Key operated or password protected switch. Mount in cover of enclosure to simulate failure of normal source.

D. Engine Start Signal: Rated 10 amps at 30VDC shall be provided to start the engine generator in the event of a normal source outage.

E. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.

F. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

G. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed indicating switch to normal source or emergency source.

H. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value, values shall be field adjustable.
I. Alternate Source Monitor: Monitor each line of alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent Hertz from rated nominal voltage, values shall be field adjustable.

J. Engine Exerciser: Start engine every 28 days. Run for 30 minutes before shutting down. Each event shall be configurable for Test with Load or Test Without Load. Bypass exerciser control if normal source fails during exercising period.

K. In-Phase Monitor: Inhibit transfer until source and load are within 30 electrical degrees.

L. Provide 2 N.O. and 2 N.C. isolated contacts to indicate:
   1. Normal source available.
   2. Emergency source available.
   3. Exercise mode in operation.

M. Communications Module - Shall provide remote interface module to support monitoring of vendor’s transfer switch, controller and optional meter. Module shall provide status, analog parameters, event logs, equipment settings and configurations over embedded webpage and open protocol. Features shall include:
   1. Email notifications and SNMP traps of selectable events and alarms may be sent to a mobile device or PC.
   2. Modbus TCP/IP, SNMP, HTTP, SMTP open protocols shall be simultaneously supported.
   3. Web app interface requiring user credentials to monitor and control the transfer switch supporting modern smart phones, tablets and PC browsers. User will be able to view the dynamic one-line; ATS controls status, alarms, metering, event logging as well as settings.
   4. Secure access shall be provided by requiring credentials for a minimum of 3 user privilege levels to the web app, monitor (view only), control (view and control) and administrator (view, control and change settings). 128-Bit AES encryption standard shall be supported for all means of connectivity.
   5. Shall allow for the initiating of transfers, retransfers, bypassing of active timers and the activating/deactivating of engine start signal shall be available over the embedded webpage and to the transfer switch vendor’s monitoring equipment.
   6. An event log displaying a minimum of ninety-nine (99) events shall be viewable and printable from the embedded webpages and accessible from supported open protocols.
   7. Four (4) 100 Mbps Ethernet copper RJ-45 ports, five (5) serial ports, Termination dipswitches and LEDs for diagnostics.
   8. DIN rail mountable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.
B. Verify field measurements are as instructed by the manufacturer.
C. Verify that required utilities are available, in proper location, and ready for use.
D. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Provide wiring to elevator controller for emergency source mode and emergency to normal pre-signal.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes materials and installation requirements for factory and field wired low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated service entrance equipment.

1.2 QUALITY ASSURANCE

A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be “Listed by Underwriters Laboratories” to UL 1449.
B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

1.3 REFERENCES

B. ANSI/IEEE C62.35 - IEEE Guide on Testing of SAD components
C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits
F. CBEMA - Computer Business Equipment Manufacturers Association
G. IEC 664 - International Engineering Consortium, Standard for Clamping Voltage
H. National Electrical Code 285 - Surge Protection Devices
I. NFPA 70 - National Electrical Code
J. UL 67 - Listed for Internal Panelboard Transient Voltage Surge Suppressors
K. UL 96A - Devices listed as approved for secondary surge arrestors (VZCA)
L. UL 248-1 - Fusing
M. UL 1283 - Electromagnetic Interference Filters, Fifth Edition

1.4 SUBMITTALS

A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under “Testing, Warranty and Life Expectancy” as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.
B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

1.5 SPARE PARTS

A. Surge Protection Modules: Furnish 1 replacement module for each type installed.
B. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.
1.6 TESTING, WARRANTY AND LIFE EXPECTANCY

A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.
   2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50μs, 6000V open circuit voltage waveform and an 8 x 20μs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit’s suppression voltage (VPR).
   3. A single 8 x 20μs waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit’s survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.

B. Minimum Repetitive Surge Current Capacity:
   1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
   2. Minimum Repetitive Surge Current Capacity Test:
      a. An initial UL 1449 surge defined as 1.2 x 50μs, 6000V open circuit voltage waveform and an 8 x 20μs, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit’s suppression voltage.
      b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50μs 10kV or 20kV open circuit voltage waveform and an 8 x 20μs 10,000A short circuit current waveform, shall then be applied at one-minute intervals.
      c. To complete the test, another UL 1449 surge shall be applied to verify the unit’s survival.
   3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.
   4. Proof of such testing shall be the test log generated by the surge generator.

C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination surge wave.

D. Warranty: Ten (10) years. Includes workmanship, installation and programming.

E. No scheduled parts replacement or preventative maintenance shall be required.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems. The short circuit current rating shall be the larger of the listed value on the drawings or as required by the equipment protected.

2.2 RATINGS

A. [SPD-1]: Service Entrance Suppressors:
   1. For 277/480-volt, 3 phase, 4 wire, type 2, category C3 unit.
      a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
      b. Nominal Discharge Current: 20 kA.
      c. Mounting: Refer to the drawings.
      d. Voltage Protection Rating: Refer to requirements below.
      e. Components: Minimum component size of 20mm thermally protected metal oxide varistors (MOV).
      f. Disconnect: Surge-rated disconnect with 200,000 SCCR.
   2. Approved Manufacturers:
      a. Square D Surgelogic EMA Series
      b. Siemens TPS3 Series
c. Eaton SPD Series
d. Current Technology Current Guard Plus
e. ASCO Power Technologies 400 Series
f. LEA International LSS Series

B. [SPD-2]: Secondary Distribution Suppressors:
   1. For 120/208 -volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
      a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
      b. Nominal Discharge Current (I_n): 20 kA.
      c. Mounting: Refer to the drawings.
      d. Voltage Protection Rating: Refer to requirements below.
      e. Components: Minimum component size of 20mm metal thermally protected oxide varistors (MOV).

C. Voltage Protection Rating:
   1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).
      a. 277/480 Volt, 3 phase, 4 wire.1200 Volt L-N, L-G, N-G and 1800 Volt L-L
      b. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L

D. EMI/RFI Noise Rejection or Filtering:
   1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.

E. Indication:
   1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.
   2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
   3. Provide each service entrance secondary distribution type unit(s) with a transient counter.
   4. Each unit shall contain form “C” contacts for remote indication of an alarm status.

F. Fuses:
   1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
   2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.
B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

3.2 INSTALLATION

A. Mounting Location:
   1. The unit shall be installed as close as practical to the panel secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer’s recommended installation instructions. Connect the unit to the panel using a conduit nipple. Flush mount the unit in the front of the switchboard. Mount unit directly across from the breaker or disconnect serving it.
   2. If internal surge protection device is specified, device shall be installed in a barrier compartment isolated from other components.

B. Connections:
   1. Conductors from the protected bus to the unit shall not be any longer than necessary avoiding unnecessary bends. The conductor leads shall be twisted together and as short as possible. Connection shall be with mechanical lugs for each phase, neutral, and ground if applicable. Contractor shall provide wire and circuit breakers sized per the approved manufacturer’s requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer’s requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard or be equipped with a factory supplied integral fused switch or circuit breaker.

3. Neutral and ground shall not be bonded together at secondary panelboard locations.

C. General:
1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Interior luminaires and accessories
B. Exterior luminaires and accessories
C. Light-emitting diode (LED) luminaire systems
D. LED emergency lighting units
E. Emergency exit signs

1.2 RELATED SECTIONS
A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
   1. 26 09 33 Lighting Control Systems
   2. Electrical drawings: Plans, luminaire schedules, diagrams, and details

1.3 REFERENCES
A. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement
C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment
D. IEEE C2 - National Electrical Safety Code
E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System
F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products
G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED
I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)
J. UL 924 - Standard for Emergency Lighting and Power Equipment

1.4 SUBMITTALS
A. Submit product data under provisions of Section 26 05 00.
B. Basic Requirements of Submittal:
   1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire’s, LED light engine, driver information following luminaire’s product data. Failure to organize submittal in this manner will result in the submittal being rejected.
   2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
   3. Include outline drawings, support points, weights, and accessory information for each luminaire.
   4. Submit manufacturer origin of LED chipset and driver.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site. Store and protect under provisions of Section 26 05 00.
B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.
1.6 WARRANTY

A. The warranty period begins at the date of Substantial Completion.
B. LED Light Engines and Drivers:
   1. LED Drivers and Dimming Drivers: Five (5) years
   2. Light Emitting Diode (LED) Light Engines: Five (5) years
C. Emergency Lighting Units and Exit Signs:
   1. Emergency Lighting Units: Three (3) year, non-prorated
   2. Exit Signs: Three (3) year, non-prorated
   3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.

1.7 REGULATORY REQUIREMENTS

1. Conform to NFPA 101 for installation requirements

PART 2 - PRODUCTS

2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction. Provide ballast covers to separate inboard/outboard lamps when multi-level switching is indicated, so light does not spill into unlit cells.
B. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.
C. Painted reflector surfaces shall have a minimum reflectance of 90%.
D. All painted components shall be painted after fabrication.

2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.
B. Provide low temperature ballasts or LED drivers, with reliable starting to -20°F.
C. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

2.3 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

A. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.
B. Rated life shall be minimum of 50,000 hours at L70.
C. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
D. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.
E. LED light engine shall have a maximum LLD of 0.85 at 50,000 hours at 25°C ambient.
F. LED Driver:
   1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 20%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
   2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.
   3. Driver shall have a minimum of 50,000 hours rated life.
4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
5. Driver shall be field replaceable without removal of the luminaire.
6. Class A sound rating; inaudible in a 27 dBA ambient.
7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

2.4 EMERGENCY EXIT SIGNS

A. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. Provide a minimum of two (2) #12 gauge wires located on diagonal corners of luminaires. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.

B. Industrial Pendant Luminaires: Use power hook hangers rated 500 pounds minimum or provide safety chain between ballast and structure. Provide safety chain between reflector and ballast.

3.2 CONSTRUCTION USE OF PROJECT LUMINAIRES

A. The Contractor shall provide temporary construction lighting per the requirements of Division 1.
B. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

3.3 EXIT SIGNS

A. Install units plumb and level.
B. Aim directional lamp heads as directed.
C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.4 RELAMPING

A. Replace failed LED light engine modules or arrays at completion of work.

3.5 ADJUSTING AND CLEANING

A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.
B. Touch up luminaire pole finish at completion of work.
3.6 **OWNER TRAINING**

A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner's Representative.

B. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.7 **LUMINAIRE SCHEDULE**

A. As shown on the drawings.

**END OF SECTION **
PART 1 - GENERAL

1.1 SCOPE
A. Monitoring Computer System and Software.
B. Description of Operation.
C. Control Devices.
D. Control Panels.

1.2 REFERENCES
A. NEMA ICS-2 - Industrial Control Devices, Controllers and Assemblies.
B. NEMA 250 - Enclosures for Electrical Equipment.
C. UL 508 - Industrial Control Equipment.
D. UL 913 - Intrinsically-Safe Apparatus.
E. NFPA 70 - National Electric Code

1.3 SUBMITTALS
A. Submit product data under provisions of Sections 26 05 00 and 01 11 00 for all devices and equipment in this specification.
B. Submit cut sheets and descriptive literature for all control devices such as switches, pushbuttons, lamps, alarms, sensors, cables, etc.
C. Include dimensioned outline drawings of all control panels showing device locations located in the interior and exterior of panels.
D. Include schematic diagrams showing interconnection of all wiring, switches, meters and lights (including terminal block and wire number) in a ladder diagram format.
E. Provide complete operating data, system drawings, wiring diagrams, and written detailed descriptions of sequences. One copy of the control diagram shall be placed inside each control panel. Provide pocket inside the door.
F. Submit operation and maintenance data. Include systems descriptions, setpoints, and controls settings and adjustments. Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
G. Submit proposed computer graphic displays in rough format. These shall be reviewed with the Owner and Engineer in a face-to-face meeting to explain and determine the layouts. A minimum of one 4-hour meeting will be required. The graphical screens shall be submitted a minimum of 10 business days prior to meeting.
H. At project completion, submit as-built drawings and PLC programs in electronic format. All software shall be documented indicating exactly what is done in each programming block.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site under provisions of Section 26 05 00.
B. Store and protect products under provisions of Section 26 05 00.
C. Handle all control panels carefully to prevent damage of devices and finish.

1.5 SYSTEM DESCRIPTION
A. General Scope of Work:
1. Install a PLC based control panel for control and monitoring of pumps, pressure sensors, flow meters and lights for automatic operations of a domestic water booster pump station.
2. The software, programming, testing and commissioning of the systems shall be provided by the owner.
3. Installation, wiring and terminations shall be completed by the contractor.
B. The material described in this section shall be provided by one control system manufacturer who shall coordinate all equipment interfacing and all schematic diagrams.
C. The manufacturer shall provide installation, inspection, calibration, startup and operation instruction services necessary for a complete and functional system. The Engineer shall be notified one week in advance before said instructions to have the option of attending some or all the training.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in designing, manufacturing, and testing a complete supervisory and process control system as specified in this section. Provide documentation to show recognition by Underwriters Laboratories, Inc. Equipment shall be UL 508, Industrial Control Equipment - Industrial Control Panels listed.
B. Installer: Company specializing in applying the work of this section with minimum three years’ experience. The service technicians shall be full time employees of the manufacturer and be certified to perform the required work.
C. The supplier shall utilize its own facilities and employees to design, assemble, program and test the system.
D. The manufacturer shall be capable of offering extended service agreements upon completion of the warranty period.
E. The supplier shall have 24 hour, 7 days per week, 365 days per year emergency services available.

1.7 WARRANTY

A. Provide one-year warranty period on all materials and labor. The warranty period shall begin at ‘Substantial Completion’
B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one-year warranty period.

1.8 TRAINING

A. The manufacturer shall be well versed in the proper operation and calibration of all devices/sensors used on the project.
B. The manufacturer shall be prepared to give training on devices.

PART 2 - PRODUCTS

2.1 PUMP STATION CONTROL PANEL (PLC-1)

A. Construct in a double door, NEMA 4 painted steel, cabinet, 72” high cabinet plus mounting legs, 60” wide, 20” deep, free standing, floor mounted. Provide lockable latches with keys and ground lugs inside the cabinet.
B. Provide programmable logic controller (PLC) as described elsewhere in this section.
C. Provide panel-mounted graphical touchscreen for control and monitoring interface (as detailed in this section).
D. Provide Ethernet communications as required for connections to:
   1. Variable frequency drives
   2. Generator control panel
   3. Power monitor
   4. Wireless radio modem
E. Provide Ethernet switch as required to maintain a minimum of two spare Ethernet ports after all required equipment have been connected.
F. Provide approximately 1.0 square foot of mounting space for owner provided radio modem.
G. Provide transient voltage surge suppressor as described elsewhere in this section.
H. Provide interior audible alarm.
I. Provide uninterruptable power supply (UPS) system capable of supplying PLC power supply backup for a minimum 30 minutes, until generator power has stabilized.
J. Provide interior LED light fixture to light upon door opening.
K. Provide remote ethernet connection on front of door with dust-proof cover.

L. Provide isolation modules on all 4-20 mA inputs to the PLC.

M. Provide circuit breakers, fuses, and other devices as required.

N. Provide the following pushbutton switches (on panel face):
   1. None

O. Provide a rotary switch (two position locked or unlocked, on panel face):
   1. Software lock

P. Provide the following selector switches (on panel face):
   1. None

Q. Provide indicator lights for the following:
   1. Power on

R. Provide the following inputs and outputs from PLC-1:
   1. Refer to diagrams shown on drawings.

2.2 CONTROL DEVICES

A. Programmable Logic Controller (PLC-1):
   1. The PLC shall be Allen Bradley CompactLogix model 1769. Provide necessary
digital/analog input/output cards, scanner cards, and communication ports as required.
The PLC shall be configured as required to perform the operations outline on the
drawings and in this specification.
   2. Provide with approximately 20% spare I/O for each type of I/O card used. Provide a
minimum of two (2) spare slots in the rack for the PLC. Provide necessary modules for
controlling equipment and energy meters.
   3. Outputs driving indicator lights shall be current limited or individually fused to prevent
equipment damage.

B. Touchscreen Control Panel:
   1. 15” panel-mounted industrial computer with color graphical touchscreen, mounted in front
of control panel.
   2. Touchscreen shall be Allen Bradley Panelview Model 2711P-T15C22D8S.

C. PLC Programming Software:
   1. The software is to be Allen Bradley Factory Talk 8 and will be provided and installed by
the owner.

D. Wireless Radio Modem
   1. Provided by owner, installed by systems integrator.

E. Coax Cable
   1. Coax cable for connection from PLC Control Panel to relocated antenna.
   2. Cable to be UV resistant, RG-8A/U, 50 OHM, as manufactured by Belden or equivalent.

F. Directional Antenna
   1. To be reused with new cabling.

G. Transient Voltage Surge Suppressor:
   1. UL1449 Listed Third Edition, Type 3, 5-year warranty, all-mode protection, 120 volt
operation, rated for 15,000 amp surge.
   2. Surge suppressors shall be manufactured by Leviton, Hubbell or equivalent.

H. Uninterruptible Power Supplies (UPS):
   1. The UPS shall be a modular type with integral batteries sized to handle all internal loads
to the PLC cabinet for a minimum of 30 minutes.
   2. The PLC control panel shall have a 120 volt, 20 amp convenience receptacle connected
to the UPS for maintenance purposes.
   3. UPS shall be manufactured by Vertiv (Liebert), Triplite or equivalent.

I. Digital Power Meters:
   1. Digital power monitors shall monitor three phase voltage, current, frequency and min/max
for current, voltage, power factor, frequency, watts, VAR, VA, and total energy.
   2. Unit shall support Modbus communications RTU or Modbus TCP/IP via the correct
communications cable connection. Refer to Specifications Section 26 09 13 for more
information.
J. Isolation Modules:
   1. Isolation modules shall be provided for all inputs to the PLC and on output as required for proper operation of devices. Isolators shall be output loop-powered, input loop-powered or line-powered as determined by the specific application. Modules shall be DIN rail mountable and installed in the associated supervisory process and control panel. Isolation modules shall be manufactured by Moore Industries, Action Instruments, or approved equal.

K. Temperature Switch
   1. NEMA 4X enclosure.
   2. Positive snap-action switch.
   3. 40-100 degree Fahrenheit temperature range.
   4. Discrete output on high limit or discrete output on low limit. Set as shown on drawings.
   5. Chromalox WCRT or approved equivalent.

L. Data Cabling:
   1. Data cabling shall be industrial grade Category 6, non-shielded, with a yellow exterior jacket. Provide jacks and plugs to connect to equipment as required. Cabling shall be manufactured by Commscope, Panduit or Belden.

M. Terminal Strips:
   1. All external connections from the control panels to devices, such as remote selector switches or motor control centers, shall be made at terminal strips. All terminals shall be numbered with the identical number as the wires attached to them. Terminals shall be UL listed and rail mounted with box type terminals. Terminals shall be rated for 600 volts and 30 amps. Barrier strips are unacceptable. All connections shall be screw terminals. Spring-loaded connections are not acceptable.

N. Wire Identification:
   1. All wires shall be individually identified with a Brady sleeve wiring tag with laser-printed numbering at each connection point. The wire number shall be cross-referenced to the rung numbers on the schematic diagrams. As-built diagrams shall be provided showing all wire numbers as installed.

O. Wire Management:
   1. The interior of all control panels shall include wire management devices (wire ducts) as manufactured by Panduit. Wire ducts shall have a removable cover. Provide adequate size to allow a maximum of 40% fill. All wiring within the control panels shall be installed in the duct, including internal wiring and field connection wiring.

P. Conductors:
   1. All wire shall be stranded copper, adequately sized to provide the appropriate power to the device. Minimum wire size shall be #16 AWG except for low voltage communication wiring and ribbon cables.

Q. Receptacle:
   1. Provide one (1) duplex, 120 volt, 15 amp NEMA 5-15R receptacle with ground fault protection (Hubbell GF5262GY or equivalent). Provide with standard nylon coverplate. Receptacle and coverplate to be ivory in color. Mount one (1) receptacle inside each panel enclosure containing a PLC, or as indicated on the drawings.

R. Fuse Blocks:
   1. UL listed, CSA certified; listed for use with fuse types used. Phenolic base, box terminal conductor terminations. Provide rejection clips for fuse holders used for Class R fuses.

S. Control Relays:
   1. Control relays shall be provided as required for the operation of the equipment. The relays shall be rated at a minimum of 10 amps at 120 volts. Relays shall have mechanical indicators for status of the contacts. Relays shall be Allen-Bradley, Bulletin 700 series.

T. Circuit Breakers:
   1. Circuit breakers for control of valves, motor starters, etc. shall be Square ‘D’ Type QO or approved equal.
U. Audible Alarms:
   1. Audible alarms shall be manufactured by Edwards System Technology, Wheelock, Mallory, or Sonalert. Alarms shall be rated at no less than 85 dB at 10 feet. Mount alarms in panel fronts of all control panels with a volume potentiometer mounted inside enclosure.

V. As-built Drawings:
   1. Complete as-built drawings shall be provided by the supplier showing all connected devices such as scales, level sensors, valves, alarms, etc.

W. Spare Parts:
   1. Provide the following spare parts: (confirm with owner)
      a. One (1) DC power supply
      b. Two (2) of each type of lamp
      c. Three (3) of each size and type of control fuses
      d. Two (2) of each type of control relays
      e. Fuse puller for each type of fuse

PART 3 - DESCRIPTION OF OPERATION

3.1 See drawings for description of operation.

PART 4 - EXECUTION

4.1 FABRICATION AND INSTALLATION

A. During startup, testing and systems checkout, the contractor shall be onsite and available to aid in point to point check out and troubleshooting.

B. Provide a testing and acceptance form during system checkout for Owner, Engineer and Controls Vendor to sign and date. The form shall acknowledge that all physical switches, indicator lights, etc. are functional, that the SCADA system functions properly, and the equipment functions as desired.

C. Shop assemble enclosures and cabinets housing terminal block and electrical components in accordance with ANSI/NEMA ICS 6. Install components described above.

D. Provide necessary conduit hubs on enclosures.

E. Provide protective pocket inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.

F. Install cabinets and enclosures plumb. Anchor securely to walls or stands as indicated on drawings.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.
B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.
B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the security systems a finished and working system.
C. Description of systems include but are not limited to the following:
   1. Electronic intrusion detection system
   2. Fire detection and alarm
   3. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.
   4. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the “Suggested Matrix of Scope Responsibility”.
   5. Firestopping of penetrations of fire-rated construction as described in Division 7.

1.3 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.
B. Definitions:
   1. “Electrical Contractor” as referred to herein refers to the Contractors listed in Division 26 of this Specification.
   2. “Electrical Contractor” shall also refer to the Contractor listed in Division 28 of this specification when the “Suggested Matrix of Scope Responsibility” indicates the work shall be provided by the EC. Refer to the Contract Documents for the “Suggested Matrix of Scope Responsibility”.
   3. “Security Contractor” as referred to herein refers to the Contractors listed in Division 28 of this Specification.
   4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.
C. General:
   1. The purpose of these Specifications is to outline typical Electrical and Security Contractor’s work responsibilities as related to security systems including back boxes, conduit, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.
   2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor’s bid.
3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.

4. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
   a. Lighting Fixtures
   b. Gravity Flow Piping, including Steam and Condensate
   c. Sheet Metal
   d. Electrical Busduct
   e. Cable Trays, including 12" access space
   f. Sprinkler Piping and other Piping
   g. Conduit and Wireway
   h. Open Cabling

D. Electrical Contractor's Responsibility:
   1. Assumes all responsibility for all required conduit and power connections when shown on the “Suggested Matrix of Scope Responsibility” to be provided by the Electrical Contractor.
   3. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:
   1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.
   2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the “Suggested Matrix of Scope Responsibility.”
   3. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.
   4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

1.4 COORDINATION DRAWINGS

A. Definitions:
   1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
      a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
      b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
      c. Technology trades shall include, but are not limited to, technology equipment, conduit 1.5" and larger, conduit racks, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
      d. Maintenance clearances and code-required dedicated space shall be included.
   2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.
B. Participation:
1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
   a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.
3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor’s use if the contractor signs and returns an “Electronic File Transfer” waiver provided by IMEG. IMEG will not consider blatant reproduct ons of original file copies an acceptable alternative for coordination drawings.

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

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

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

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

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

1.5 QUALITY ASSURANCE

A. Qualifications:
1. Only products of reputable manufacturers as determined by the Architect/Engineer will be
acceptable.
2. Each Contractor and their subcontractors shall employ only workers who are skilled in their
respective trades and fully trained. All workers involved in the installation, termination,
testing, and placing into operation electronic security devices shall be individually trained
by the manufacturer.
3. The Contractor shall be experienced in all aspects of this work and shall be required to
demonstrate direct experience on recent systems of similar type and size.
4. The Contractor shall own and maintain tools and equipment necessary for successful
installation and testing of electronic security devices and have personnel adequately
trained in the use of such tools and equipment.

B. Compliance with Codes, Laws, Ordinances:
1. Conform to all requirements of the City of Ankeny, IA Codes, Laws, Ordinances and other
regulations having jurisdiction.
2. In the event there are no local codes having jurisdiction over this job, the current issue of
the National Electrical Code shall be followed.
3. If there is a discrepancy between the codes and regulations having jurisdiction over this
installation, and these specifications, Architect/Engineer shall determine the method or
equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications
which are not in accordance with the applicable codes or regulations, he shall inform the
Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow
this procedure, he shall submit with the proposal, a separate price required to make the
system shown on the drawings comply with the codes and regulations.
5. Verify the installation environment prior to purchasing or installing any cable. Cable
installed in a plenum environment shall be appropriately rated. Bring all discrepancies
between the contract documents and installation conditions to the attention of the
Architect/Engineer prior to purchase or installation.
6. All changes to the system made after the letting of the contract, in order to comply with the
applicable codes or the requirements of the Inspector, shall be made by the Contractor
without cost to the Owner.

C. Permits, Fees, Taxes, Inspections:
1. Procure all applicable permits and licenses.
2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or
Political Subdivision wherein the work is done, or as required by any duly constituted public
authority.
3. Pay all applicable charges for such permits or licenses that may be required.
4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory
bodies.
5. Pay all charges arising out of required inspections due to codes, permits, licenses or as
otherwise may be required by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.

7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)
   a. Factory Mutual
   b. Underwriters' Laboratories, Inc.

D. Examination of Drawings:
1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.
3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.
5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.
6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

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

F. Field Measurements:
1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.6 SUBMITTALS

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

1. Submittals list:

<table>
<thead>
<tr>
<th>Section</th>
<th>Submittal Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 16 00</td>
<td>Intrusion Detection System</td>
</tr>
</tbody>
</table>
B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
   a. Date
   b. Project title and number
   c. Contractor’s name and address
   d. Division of work (e.g., plumbing, heating, ventilating, etc.)
   e. Description of items submitted and relevant specification number
   f. Notations of deviations from the contract documents
   g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors’ names and addresses
   e. Supplier and manufacturer’s names and addresses
   f. Division of work (e.g., plumbing, heating, ventilating, etc.)
   g. Description of item submitted (using project nomenclature) and relevant specification number
   h. Notations of deviations from the contract documents
   i. Other pertinent data
   j. Provide space for Contractor’s review stamps

3. Composition:
   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers’ standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor’s Approval Stamp:
   a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
   b. Unstamped submittals will be rejected.
   c. The Contractor’s review shall include, but not be limited to, verification of the following:
      1) Only approved manufacturers are used.
      2) Addenda items have been incorporated.
      3) Catalog numbers and options match those specified.
      4) Performance data matches that specified.
      5) Electrical characteristics and loads match those specified.
      6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
      7) Dimensions and service clearances are suitable for the intended location.
      8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
      9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
   d. The Contractor shall review, stamp and approve all subcontractors’ submittals as described above.
e. The Contractor’s approval stamp is required on all submittals. Approval will indicate the Contractor’s review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:
   a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
   b. The Contractor shall clearly indicate the size, finish, material, etc.
   c. Where more than one model is shown on a manufacturer’s sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
   d. All marks and identifications on the submittals shall be unambiguous.

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

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

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

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

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

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

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

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

C. Electronic Submittal Procedures:
   1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
   2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
   3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
   4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
      a. Submittal file name: 28 XX XX.description.YYYYMMDD
      b. Transmittal file name: 28 XX XX.description.YYYYMMDD
   5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.7 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:
   1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
   2. Submit in Excel format.
   3. Support values given with substantiating data.

C. Preparation:
   1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
   2. Break down all costs into:
      a. Material: Delivered cost of product with taxes paid.
      b. Labor: Labor cost, excluding overhead and profit.
D. Update Schedule of Values when:
   1. Indicated by Architect/Engineer.
   2. Change of subcontractor or supplier occurs.
   3. Change of product or equipment occurs.

1.8 CHANGE ORDERS
A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
B. Change order work shall not proceed until authorized.

1.9 EQUIPMENT SUPPLIERS' INSPECTION
A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:
   1. Firestopping, including mechanical firestop systems.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE
A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.
B. Store materials on the site to prevent damage.
C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.11 WARRANTY
A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.
B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.
C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.12 INSURANCE
A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.13 MATERIAL SUBSTITUTION
A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.
B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.
C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor
assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, this Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on this Contractor or on the part of other Contractors whose work is affected.

PART 2 - PRODUCTS

2.1 REFER TO INDIVIDUAL SECTIONS

PART 3 - EXECUTION

3.1 JOBSITE SAFETY

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor’s responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer’s recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor’s expense.

3.3 FIELD QUALITY CONTROL

A. General:
   1. Refer to specific Division 28 sections for further requirements.
   2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.
   3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.
   4. In the event the results obtained in the tests are not satisfactory, this Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.
B. Protection of cable from foreign materials:
   1. It is the Contractor’s responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer’s performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
   2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor’s responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:
   1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.

C. Before final payment will be authorized, this Contractor must have completed the following:
   1. Submitted operation and maintenance manuals to the Architect/Engineer for review.
   2. Submitted bound copies of approved shop drawings.
   3. Record documents including edited drawings and specifications accurately reflecting field conditions, inclusive of all project revisions, change orders, and modifications.
   4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.
   5. Submitted testing reports for all systems requiring final testing as described herein.
   6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.
   7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to the project site; submit receipt to Architect/Engineer prior to final payment being approved.

3.5 OPERATION AND MAINTENANCE MANUALS

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

B. Electronic Submittal Procedures:
   1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
   2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
   3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not
set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
   a. O&M file name: O&M.div28.contractor.YYYYMMDD
   b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

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

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

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

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

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

D. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.

E. Refer to the individual specification sections for minimum hours of instruction time for each system.

F. Operating Instructions:
   1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.
   2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care
and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

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

3.8 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer’s hourly rates in effect at the time of work.

D. Record actual routing of all conduits sized 2” or larger.

E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.
3.10 CONSTRUCTION WASTE MANAGEMENT

A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).

1. This Contractor shall coordinate with the General Contractor to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.

2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor’s scope of work. The Contractor shall provide this information to the General Contractor so that it can be incorporated with similar information from all other contractors for the project.

   a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor to establish the preferred calculation method and report the results accordingly.

   b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES
A. Security Control Panel.
B. Initiation Devices.
C. Notification Devices.

1.2 RELATED WORK
A. Section 26 05 33 - Conduit and Boxes
B. Section 26 05 13 - Wire and Cable
C. Section 28 05 00 - Basic Electronic Safety and Security System Requirements
D. Section 28 31 00 - Fire Detection and Alarm Systems

1.3 QUALITY ASSURANCE
A. Manufacturer: The intrusion detection system shall be a single-source manufacturer such that the single vendor distributes, supports, warranties and services all components. The manufacturer shall have a minimum of five (5) years documented experience.
B. Installer: The installing dealer must be a factory-authorized service and support company specializing in the selected manufacturer’s product, with demonstrated prior experience with the selected manufacturer’s system installation and programming.
C. Servicing Contractor: The manufacturer of the system must have local service representatives within 60 miles of the project site.

1.4 SUBMITTALS
A. Submit shop drawings and product data under provisions of Section 28 05 00.
B. Product Data Submittal: Provide manufacturer’s technical product specification sheet for each individual component type. Submitted data shall show the following:
   1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.
   2. All component options and accessories specific to this project.
   3. Electrical power consumption rating and voltage.
   4. Wiring requirements.
C. System Drawings: Project-specific system CAD drawings shall be provided as follows:
   1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (i.e., multiple identical controllers), the diagram may show one device and refer to the others as “typical” of the device shown.
   2. Provide schedules describing each system input location by an architecturally familiar reference (i.e., Door 312A). The architectural door schedule shall be used as the basis.
D. Submit detailed description of Owner training to be conducted at project end, including specific training times.
E. Quality Assurance:
   1. Provide materials documenting experience requirements of the manufacturer and Installing Contractor.
   2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.
F. Coordination Drawings:
   1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 28 05 00 for coordination drawing requirements.
1.5 SYSTEM DESCRIPTION
A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey intrusion detection system.
B. Performance Statement: This specification section and the accompanying intrusion detection-specific design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
C. Basic System Description: The intrusion detection system shall provide a contact closure interface with an existing local PLC system.

1.6 PROJECT RECORD DOCUMENTS
A. Submit documents under the provisions of Section 28 05 00.
B. Provide final system block diagram showing any deviations from shop drawing submittal.
C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.
D. Provide schedules documenting:
   1. Controller installation locations including specific zones and initiation devices being on the system.
   2. All terminal block wiring, including cable numbers.
E. Warranty: Submit written warranty and complete all Owner registration forms.
F. Complete all operation and maintenance manuals as described below.

1.7 OPERATION AND MAINTENANCE DATA
A. Submit documents under the provisions of Section 28 05 00.
B. Operation Data: Provide full system operation instructions for each piece of equipment.
C. Maintenance Data: Document any manufacturer’s recommended preventative maintenance procedures to be performed by the Owner.

1.8 WARRANTY
A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.
B. The warranty shall include emergency service and repair on-site, with acknowledgment response time of one (2) hours from time of notification and on-site response within twelve (21) hours. The system shall be repaired and restored to operation within forty-eight (48) hours of notification.
C. Refer to the individual product sections for further warranty requirements of individual system components.

PART 2 - INTRUSION DETECTION PRODUCTS

2.1 INTRUSION DETECTION SYSTEM MANUFACTURERS
A. Honeywell

2.2 SECURITY CONTROL PANEL
A. Control Panel: Modular construction with surface wall-mounted enclosure.
B. Power Supply: Adequate to serve control panel modules, remote detectors, remote annunciators, relays, and alarm signaling devices. Include battery operated emergency power supply with capacity for operating system in standby mode for 72 hours.
C. System Supervision: Provide electrically-supervised system, with supervised alarm initiating and alarm signaling circuits. Component or power supply failure places system in alarm mode.
D. Initiating Circuits: Supervised zone module with alarm and trouble indication.
E. Signal Circuits: Supervised zone coded signal module, sufficient for signal devices connected to system; occurrence of single ground or open condition places circuit in trouble mode and does not disable that circuit from transmitting alarm.
F. Auxiliary Relays: Provide sufficient SPDT auxiliary relay contact for general alarm to existing local PLC system.
G. Basis of Design: Honeywell VISTA-21iP with 6150 keypad, no substitutions.

2.3 INITIATION DEVICES
A. Motion Detectors:
   1. Passive infrared, wall mounted, 12 VDC.
   3. Fresnel pattern lens with a minimum of a 30-zone pattern.
   4. Basis of Design: Honeywell IS216, or preapproved equal.

2.4 NOTIFICATION DEVICES
A. Alarm Horn:
   1. Wall mounted.
   2. Piezo siren type, with alternating high/low sound.
   3. 106 dB at 10’.
   4. 6 to 13.8 VDC operation.
   5. Basis of Design: Honeywell Wave2, or preapproved equal.

PART 3 - EXECUTION
3.1 INSTALLATION
A. Comply with the manufacturer’s instructions and recommendations for installation of all products.
B. Provide all system wiring between all components as directed by the manufacturer.

3.2 FIELD QUALITY CONTROL
A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.
B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the Contract Documents.

3.3 MANUFACTURER’S FIELD SERVICES
A. Installation shall be performed by a factory-trained and certified Contractor Installer.
B. It shall be the responsibility of the Contractor/Installer to provide a complete, functional system as described by the Contract Documents. These responsibilities include:
   1. Complete hardware setup, installation and wiring, and software configuration of the system.
   2. Complete programming of all operator software in accordance with the Owner’s security policies determined by the planning guide conference.
   3. Complete system diagnostic verification.
C. The Installation Contractor shall be present at two (2) four-hour meetings to coordinate all door hardware requirements with the door hardware vendor.

3.4 SYSTEM ACCEPTANCE
A. The Vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components and software. The Contractor shall perform the tests and document all results under the supervision of the manufacturer’s system engineer.
B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

3.5 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:
   1. All operational parameters of the system.

B. The following sections shall be provided in the system documentation:

3.6 SYSTEM TRAINING

A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.

B. Provide two weeks advanced notice of training to the Owner.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:
   1. Alarm Users: Provide a detailed course outlining the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control and general overview of the report hardware.

E. Minimum on-site training times shall be:
   1. Alarm Users: One day.

** END OF SECTION **
PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fire alarm and detection systems

1.2 RELATED WORK

A. Section 26 05 53 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 QUALITY ASSURANCE

A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years’ experience.

B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with five years’ experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.

C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person’s name and certification number shall appear on the start-up and testing reports.

1.4 REFERENCES

A. NFPA 70 - National Electrical Code

B. NFPA 72 - National Fire Alarm and Signaling Code


D. UL 2017 - General Purpose Signaling Devices and Systems

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00 and as noted below.

1. Failure to comply with all the following and all the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.

2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.

B. Provide product catalog data sheets as shop drawings.

1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings but required for the operation of the system.

2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.

3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.

C. Submit CAD floor plans as shop drawings:

1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer’s wiring requirements shall be shown.

2. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.

D. About all fire alarm circuits, provide the following: manufacturer’s wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.

E. Provide installation and maintenance manuals under provisions of Section 26 05 00.

F. Submit manufacturer's certificate that system meets or exceeds specified requirements.

G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.
H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.

I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a Professional Engineer’s stamp and signature of the state in which the project is completed. NOTE: The Owner/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.
B. Store and protect products under provisions of Section 26 05 00.

1.7 REGULATORY REQUIREMENTS

A. System: UL or FM Global listed.
B. Conform to requirements of NFPA 101.
C. Conform to requirements of Americans with Disabilities Act (ADA).
D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling.

1.8 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.

C. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.

D. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.

E. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.

F. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.

G. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown but shall be submitted on the shop drawings.

1.9 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 26 05 00.
B. Include location of end-of-line devices.
C. Provide a CAD drawing of each area of the building (minimum scale of 1/16” = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
D. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.
1.10 OPERATION AND MAINTENANCE DATA
A. Submit data under provisions of Section 26 05 00.
B. Include operating instructions, and maintenance and repair procedures.
C. Include results of testing of all devices and functions.
D. Include manufacturer’s representative’s letter stating that system is operational.
E. Include the CAD floor plan drawings.
F. Include shop drawings as reviewed by the Owner/Engineer and the local Authority Having Jurisdiction.

1.11 WARRANTY
A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
A. Notifier by Honeywell

2.2 [FAP-#]: FIRE ALARM CONTROL PANEL (FAP)
A. Control Panel: Modular, power-limited electronic design. Provide surface wall-mounted enclosure as shown on plans. Enclosure shall be minimum 0.060 steel with provisions for electrical conduit connections into the sides and top. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators.
B. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer’s system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop.
C. Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC) Boards:
1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.
2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.
D. Central Processing Unit:
1. The central processing unit (CPU) shall communicate with the monitor and control all other modules in the panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the CPU.
2. The CPU shall execute all control-by-event programs for specific action to be taken if a designated situation is detected in the system. A real-time system clock for time annotations on the display and printer shall be included.
3. All power for the unit shall be supervised and supplied by the FAP.
E. Display:
1. The board shall provide all controls and indicators used by the system operator and may also be used to program all control panel parameters.
2. The board shall provide an alphanumeric array for display of custom alphanumeric labels for all addressable points. It shall also provide indicators for AC Power, System Alarm, System Trouble, Display Trouble and Signal Silence.
3. Displayed descriptions of addressable points shall include actual room names/numbers selected by the Owner. This information shall be obtained prior to programming. Room names/numbers shown on floor plans shall not be used.
4. The board shall provide a touch key-pad with control capability to command all system functions and entry of any alphanumeric information. Twenty different passwords with four
levels of security shall be supported to prevent unauthorized manual control or programming.

F. Memory: The CPU and display interface board shall be augmented by non-volatile field programmable memory. EPROM memory will also be allowed provided the memory is burned in with minimum expansion capability equal to the total system capacity of the panel. Memory shall not be lost upon primary and secondary power failure.

G. Power Supply:
1. Input power shall be 120 VAC, 60 Hertz. Output power shall be as noted on the device specifications and drawings. Each component of the fire alarm system requiring 120 VAC input power shall be served from a dedicated emergency branch circuit. Provide two #12 conductors and one #12 ground in 3/4” conduit to a dedicated 20A/1P circuit breaker with a red handle and a manufacturer’s standard handle lock-on device. Identify/label breaker and branch circuit in accordance with NFPA requirements and Specification Section 26 05 53.
2. Adequate to supply 125% of all control panel and peripheral power needs as well as 125% of power required for all external audio-visual devices. The power supply may be increased as needed by adding additional modular expansion power supplies. Over-current protections shall be provided on all power outputs.
3. All power supplies shall be designed and installed to meet UL and NFPA requirements for power-limited operation on all external initiating and indicating circuits.
4. The power supply shall provide integral charger for use with internal batteries. Battery capacity shall be sufficient for operation of the entire system for 24 hours in a non-alarm state followed by alarm mode for 15 minutes, plus 25% spare capacity for future devices.

H. Surge Protection:
1. All fire alarm control panels, NAC panels, etc. shall be provided with a surge protection device (SPD). The SPD shall be UL listed to Standard 1449 Rev 3. The unit should be clearly labeled in accordance with Identification Section 26 05 53. The SPD shall have thermal fuses to protect against fire in short circuit conditions. The unit shall provide visual indication that the unit is protecting and functioning.
2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

2.3 SIGNALING LINE CIRCUIT DEVICES

A. Manual Pull Stations:
1. Manual stations shall match the description on the drawings (refer to the General Electrical Equipment Schedule). The stations shall be mounted where shown on the drawings and be provided with all necessary mounting hardware. Use surface mount only on precast concrete or structure. WG subscript indicates wire guard is required.
2. [FA-130]: Addressable, single action with plastic breakrod, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Shutdown.
3. Manual stations shall connect directly to an SLC loop. Stations shall provide address setting means using rotary decimal or DIP switches.
4. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location, with maintained temperatures between 32°F and 120°F.

B. Heat Detectors:
1. [FA-140]: Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
   a. A subscript is used to identify the device with a specific sequence of operation as follows: E=Elevator Shutdown.
2. [FA-141]: 200°F fixed temperature. Provide a remote addressable monitor module to interface with addressable system as shown on the plans.
3. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
4. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.

5. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.

6. Provide a remote LED indicator device if detector is not visible from a floor-standing position.

7. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.

8. A test means shall be provided to simulate an alarm condition.

9. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

C. **[FA-160]:** Monitor Modules:

1. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.

2. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.

3. The module shall supply the required power to operate the monitored device(s).

4. The module shall provide address setting means using rotary decimal or DIP switches.

D. **[FA-161]:** Addressable Relays:

1. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional slave relay(s), as required, rated for the electrical load being controlled (contractor to match voltage, amps, etc.).

2. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.

3. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.

4. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

### 2.4 NOTIFICATION APPLIANCE DEVICES

A. Device Color:

1. Wall Mounted: Selection by owner.

2. Ceiling Mounted: Selection by owner.

3. WG subscript indicates wire guard is required.

B. Visual Alarm Devices:

1. **[FA-200]:** Wall mounted.

2. **[FA-201]:** Ceiling mounted.

3. High intensity (candela rating as scheduled on the drawings) xenon strobe or equivalent under a lens. Candela rating shall be visible from exterior of the device.

   a. Candela Ratings: V1=15, V3=30, V7=75, VH=110, VS=177.

4. The maximum pulse duration shall be 0.2 seconds with a maximum duty cycle of 40%. The flash rate shall be 1 Hz. Where more than two strobes are visible from any one location, the fire alarm visual devices shall be synchronized.

5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

C. Audio Horn Alarm Devices:

1. **[FA-210]:** Wall mounted.

2. **[FA-230]:** Ceiling mounted.

3. Sound Rating: 85 dBA at 10 feet. Sound levels for alarm signals shall not exceed 120 dBA in the occupied area.
4. Device shall be capable of a high and low dB level setting. Unless noted otherwise, the device shall be set to the high setting at building completion.

5. Device, housing, and backbox shall be UL listed for fire alarm/emergency applications.

D. Combination Audio Horn and Visual Notification Device:
1. [FA-211]: Wall mounted.
2. [FA-231]: Ceiling mounted.
3. Combine horn and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.

E. [FA-212]: Weatherproof Audio/Visual Notification Device:
1. Electronic horn with high intensity strobe, square housing, 75 candela, suitable for wet locations. Provide with weatherproof back box.
3. Conduit shall not be exposed.

2.5 [NEP-#]: NAC EXTENDER PANELS (NEP)

A. As shown on the plans or as a Contractor’s option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NEP on the shop drawing submittals.

B. Each NEP shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NEP provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.

C. Power for each NEP shall be from a local 120 VAC emergency circuit. Provide two #12 conductors and one #12 ground in 1/2” conduit to each NEP from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer’s standard handle lock-on device. Coordinate panel and circuit number with Owner/Engineer prior to installation.

D. Mounting: Surface.

2.6 ANNUNCIATION

A. PLC Interface:
1. Provide addressable relays to report the following to the PLC via dry contact monitoring on the PLC:
   a. General Alarm
   b. System Trouble
   c. Supervisory Alarm

2.7 WIRING

A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer’s recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with NFPA 70, Article 760 for power-limited fire alarm signal service.

B. Approved manufacturers of fire alarm cable:
1. Comtran Corp.
2. Helix/HiTemp Cables, Inc.
3. Rockbestos-Suprenant Cable Corp.
4. West Penn Wire/CDT.
5. Radix.

PART 3 - EXECUTION

3.1 SEQUENCES OF FIRE ALARM OPERATION

A. General:
1. Refer to the Fire Alarm Operation Matrix on the drawings for basic requirements and system operation.
2. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:
   1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
   2. A local signal in the control shall sound.
   3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
   4. History storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
   5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
   6. Transmit the appropriate signal (supervisory, trouble, alarm) to the PLC via addressable relays tied to contact monitors on the system.

C. Audible Alarms Sequence:
   1. Audible alarms throughout the building shall sound.

D. Visual Alarms Sequence:
   1. Visual alarms throughout the building shall flash.

3.2 INSTALLATION

A. Install system in accordance with manufacturer's instructions and referenced codes.

B. Fire Alarm Control Panel:
   1. Install the control panel where shown on the drawings.
   2. All expansion compartments, if required, shall be located at the control panel.

C. Devices:
   1. General:
      a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
      b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
      c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.
      d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.
   2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.
   3. Protection of Fire Alarm System:
      a. A smoke detector shall be installed within the vicinity of the main fire alarm panel and every NAC extender panel per NFPA 72. A heat detector may be substituted when a smoke detector is not appropriate for the environment of installation.
   4. Manual Pull Stations:
      a. Stations shall be located where shown and at the height noted on the drawings.
   5. Addressable Relays and Monitor Modules:
      a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
      b. All modules shall be mounted in or on a junction box in an accessible location.
c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.

6. Notification Appliance Devices:
   a. Devices shall be located where shown on the drawings.
   b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.
   c. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high, they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.

D. Wiring:
   1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer’s recommendations and pursuant to National Fire Codes.
   2. Wiring shall be installed in conduit. Refer to Identification Section 26 05 13 for color and identification requirements.
   3. All junction boxes with SLC and NAC circuits shall be identified on cover.
   5. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
      a. Fire alarm temporal audible notification for all audio appliances.
      b. Synchronization of all visual devices where two or more devices are visible from the same location.
      c. Ability to silence audible alarm while maintaining visual device operation.
   7. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with “E-Z Markers” or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

E. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows or using colored tape at each conductor termination and in each junction box.
   1. Power branch circuit conductors: In accordance with Section 26 05 53.
   2. Signaling line circuit: Overall red jacket with black and red conductors.
   3. DC power supply circuit: Overall red jacket with violet and brown conductors.
   4. Notification appliance circuit: Overall red jacket with blue and white conductors.
   7. Central station fire alarm loop: Black and white conductors.

F. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.

G. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer’s product data and shop drawings.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 05 00.
B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.
Contractor shall test and adjust the fire alarm system as follows:

1. Speaker taps shall be adjusted to the lowest tap setting which achieves a sound level higher than or equal to the greatest of the following:
   a. 70dBA.
   b. 15 dBA above ambient levels as indicated in NFPA 72 Table A.18.4.3.
   c. 15 dBA above measured ambient. 5 dBA above the maximum measured sound level with duration of more than 60 seconds.
   d. As specified on the drawings.

2. Sound level measurement procedure shall meet the following requirements:
   a. All measurements shall use the 'A' weighted, dBA, sound measurement scale.
   b. All measurements shall be taken after furnishings, wall coverings and floor coverings are in place.
   c. All measurements shall be taken after fixed equipment (HVAC units, etc.) producing ambient noise is installed and is in operation.
   d. All sound level measurements shall be taken at a height of 5' above the finished floor level.
   e. Measurements shall be taken in every unique room. If there are multiple rooms, which have the identical dimensions and function, 10%, or a minimum of 2 rooms shall be tested. The results from the rooms tested shall be averaged and the remaining rooms may be adjusted per the average.
   f. Measurements shall be taken on a 20' x 20' grid and the results for all points taken shall be averaged. If the room is smaller than 20' x 20' a minimum of two measurements are required.
   g. Measurements shall be taken halfway between speakers or halfway between a speaker and the wall. No measurements shall be taken at the extreme edges of the room, nor directly under speakers.

3.4 MANUFACTURER’S FIELD SERVICES

A. Provide manufacturer's field services under provisions of Section 26 05 00.
B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
C. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. The Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

3.5 SYSTEM TRAINING

A. System training shall be performed under provisions of Section 26 05 00.
B. Minimum on-site training times shall be:
   1. System Operators: One (1) day.
   2. Emergency Communication System: Four (4) hours.

** END OF SECTION **
SECTION 31 11 00
CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SUMMARY OF WORK
A. This Section includes the removal of surface debris, trees, shrubs, and other plant life from the site.

1.02 RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 31 22 00 – Site Grading.
C. Section 31 23 33 – Trenching and Backfilling.
D. Section 32 92 19 – Seeding.
E. Section 32 13 10 – Sidewalk, Driveways, and Temporary Access.

1.03 REFERENCES
A. Iowa Department of Transportation (IDOT), Division of Highways, English Standard Specifications for Highway and Bridge Construction, Current Edition.

1.04 SUBMITTALS (NOT USED)

1.05 MEASUREMENT AND PAYMENT
A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 PERMITS AND APPROVALS
A. Refer to Erosion and Sediment Control Permit.

3.02 GENERAL
A. Conform to applicable codes, statutes, and environmental requirements for disposal of debris.
B. Coordinate clearing work with utility companies.

3.03 PREPARATION
A. Provide Owner with minimum of 48 hours advance notice before beginning clearing activities.
B. Meet with Owner at site to review removal limits and identify trees designated for removal.
C. Verify that existing plant life designated to remain is tagged or identified.

D. Identify and prepare waste area for temporary storage of removed materials.

3.04 PROTECTION

A. Locate, identify, and protect existing utilities from damage.

B. Protect trees, plant growth, and features designated to remain at time of construction as final landscaping.

C. Protect benchmarks, survey control points, and existing structures from damage or displacement.

3.05 CLEARING

A. Clear areas required for access to site and execution of Work.

B. Clear undergrowth and deadwood without disturbing subsoil.

C. Remove all trees designated for removal on Plans. Include complete removal of root balls, large roots, and other deleterious debris.

D. Leave strips of vegetation along edges of construction limits to trap suspended solids before storm water leaves the site.

3.06 DISPOSAL OF MATERIALS

A. Remove and properly dispose of all cleared materials. Contractor may salvage any cleared materials.

B. Materials removed shall be removed from the site and disposed of by the Contractor in accordance with all local codes and ordinances. No increase in contract price shall be incurred by Owner for proper disposal of materials.

** END OF SECTION **
SECTION 31 22 00

SITE GRADING

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. Removal and stockpiling of topsoil, excavation, site grading, and filling associated with contouring of site.

B. Excavation and disposal of unstable materials. Also includes placement and compaction of select backfill material.

C. Placement and compaction of fill material.

D. Transporting in, placement, and compaction of additional fill material not available on site.

E. Placement of stabilization material.

F. Final grading and replacement of topsoil.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 31 11 00 – Clearing and Grubbing.

C. Section 31 23 33 – Trenching and Backfilling.

D. Section 32 92 19 – Seeding.

1.03 REFERENCES


B. Iowa Statewide Urban Design and Specifications (SUDAS).

C. Federal Register – Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards – Excavations.

1.04 SUBMITTALS

A. Submit documentation that any off-site sources used for obtaining borrow materials or disposal of surplus materials holds a National Pollutant Discharge Elimination System (NPDES) permit from the IDNR for storm water discharge associated with construction activity.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station. Include in costs for obtaining and transporting additional fill material in Lump Sum Bid price.
PART 2  PRODUCTS

2.01 EXCAVATION MATERIALS

A. Class 10 Excavation per Section 2010 of Iowa Statewide Urban Design and Specifications (SUDAS).

B. Refer to geotechnical report provided with Contract Documents for detailed description of materials that will be excavated.

2.02 FILL MATERIALS

A. Provide and transport to site required additional fill material.

B. Material approved for use by Engineer.

C. Selected material taken from excavation at the site or select borrow material if sufficient quantities of compliant excavated material are not available.

D. Inorganic lean clays, clayey sands, or inorganic and clayey silts, compatible with and having an obtainable density no less than adjacent soils.

E. Free of foreign debris, including rocks, organic materials, and man-made debris.

F. Material that is not frozen.

PART 3  EXECUTION

3.01 EXAMINATION

A. Verify that intended elevations for the Work are as indicated on Drawings.

B. Earthwork quantities: Site has approximately 56 cubic yards of excavation (cut) and 567 cubic yards of fill, using a shrinkage factor of 1.3, for a total excess fill of 665 cubic yards will be needed. Contractor to obtain, and transport to site, additional fill material meeting requirements of Section 2.02. Estimate only includes materials needed for final site grading. Not included in estimate is any fill needed for temporary access road or contractor storage and staging.

3.02 QUALITY ASSURANCE

A. Provide Engineer opportunity to review:
   1. Excavated or borrowed soils prior to placement.
   2. Proof rolling of areas to receive engineered compacted fill.

B. Owner will commission and compensate a qualified soils engineer to:
   1. Develop Proctor curves indicating moisture-density relationships for soil types used as backfill and fill.
   2. Conduct moisture-density tests on backfill and fill after placement to determine compliance to Specifications.
   3. Conduct on-site inspections of excavations to confirm proper application of soil types to their specified uses.

3.03 SITE PREPARATION

A. Perform surveys to identify required lines, elevations, contours, and datum necessary to control Work.

B. Stake and flag locations of known utilities.
C. Locate, identify, and protect utilities that remain from being damaged.

D. Protect above- and below-grade utilities that remain.

E. Protect plant life, lawns, and other features remaining as a portion of final landscaping.

F. Protect survey control points, monuments, and fences from excavating equipment and vehicular traffic.

3.04 STRIPPING, SALVAGING, AND SPREADING OF TOPSOIL

A. Stripping and Salvaging:
   1. Mow all weeds, grass, and growing crops or other herbaceous vegetation close to the ground and remove from site.
   2. Remove all trees designated for removal on Drawings. Include complete removal of root balls, large roots, and other deleterious debris.
   3. Dispose of vegetation according to State and County Regulations.
   4. Remove an adequate quantity of topsoil from the upper 12 inches of existing on-site topsoil to allow finish grading with 8 inches of salvaged or borrowed topsoil.
   5. Move topsoil directly to area where it will be used or stockpile for future use.

B. Preparation for Topsoil Placement:
   1. Finish excavation and grading work according to specifications and specified grades. Grade and slope all surfaces to drain away from buildings and to prevent ponding.
   2. Loosen surface to a minimum depth of 4 inches to reduce density of base soil.

C. Topsoil Spreading and Finish Grading:
   1. Place topsoil after all grading and excavation activities in the area have been completed.
   2. Place topsoil at least 8 inches deep or as specified elsewhere in the Contract Documents.
   3. Smooth to finished grades.
   4. After finish grading the topsoil, remove clods, lumps, roots, litter, other undesirable material, and stones larger than one inch.

D. Complete seeding as specified in Section 32 92 19.

3.05 EXCAVATION

A. Notify Engineer prior to the start of excavation activities.

B. Coordinate installation of slope protection and erosion control devices with excavation activities.

C. Blend natural land forms and avoid unnecessary damage to the land.

D. Drainage:
   1. Provide temporary drainage facilities to prevent damage to public or private interests when necessary to interrupt natural drainage or flow of artificial drains.
   2. Do not divert natural drainage of surface water onto adjoining properties. Use existing natural drainage courses, channels, or conditions.
   3. Restore original drainage as soon as allowable.
   4. Contractor responsible for damage resulting from their neglect to provide erosion control or artificial drainage.
E. Excavated material must be placed:
   1. To provide continuous access to work areas and Owner’s facilities at site.
   2. To minimize damage to adjacent areas.
   3. So as not to encroach beyond site boundaries.

F. Do not remove excess fill material within the perimeter of the structure and expose the floor subgrade until:
   1. All footings and piping under the floor slabs have been installed.
   2. All back-fill for footings and piping has been properly placed, compacted and tested.

3.06 PLACEMENT OF FILL MATERIAL

A. Notify Engineer prior to the start of placing fill materials.

B. Coordinate installation of slope protection and erosion control devices with placement of fill materials.

C. Site Preparation:
   1. Remove organic and all loose materials and all vegetation from areas that will receive fill.
   2. Stripping depths may vary due to localized variations in vegetative cover and soil stability.

D. General:
   1. Place fill material at, or near, optimum moisture.
   2. Integrate new fill sections into existing slopes by scarifying all existing slopes that will receive fill material.
   3. Compact fill material to a minimum of 95 percent Standard Proctor Density within a soil moisture range of optimum moisture to 4 percentage points above optimum moisture content.
   4. Fill areas to the contours and elevations shown on Drawings.
   5. Place fill material in continuous layers and compact lifts as specified. Maximum loose thickness of lifts: 8 inches.
   6. Make grade changes gradual. Blend slope into level areas.
   7. Remove surplus fill materials from site.

3.07 TOLERANCES

A. Top surface of subgrade: plus or minus 0.1 foot from required elevation.

3.08 CONTROL OF WATER

A. Conduct Work in the dry.

B. Dewater as necessary to prevent surface water from entering structures.

C. Water pumped or diverted from excavation site should not be:
   1. Pooled anywhere on site.
   2. Removed in such a manner as to disperse silt.

D. Surface water should be controlled as follows:
   1. Surface water should be diverted to prevent entry into excavations.
   2. Surface water accumulated in excavations should be removed prior to continuation of excavation work.
   3. Surface water saturated soil should be completely removed from the excavation.

E. Dewater excavations, as necessary, to permit proper execution of the Project.
3.09 DISPOSAL OF UNSUITABLE OR EXCESS MATERIAL

A. Surplus fill material or material not suitable for backfill or fill should be disposed of off-site at a location provided by the Contractor.
   1. Off-site disposal locations must hold National Pollutant Discharge Elimination System (NPDES) permit from the IDNR for storm water discharge associated with construction activity.
   2. Transportation of such material provided by Contractor.

3.10 SOIL TESTING

A. Field tests for density and moisture content:
   1. Performed by soils engineer, defined in Part 3.2 of this Section, to ensure that specified density is being obtained.
   2. Testing method: ASTM D 6938 nuclear methods or another method approved by Engineer.

B. Density Tests: taken at every lift and as directed by Engineer under special conditions.

C. Test Locations: selected by Engineer immediately prior to performing tests.

D. When test results indicate compaction is not as specified:
   1. Additional tests will be required in both directions from the failed test until satisfactory results are obtained.
   2. Remove, replace, and recompact material between the satisfactory tests in lifts to meet specifications. Compaction corrections made at no expense to Owner.
   3. Perform density tests to recompacted areas provided at the same frequency as the original tests. Testing of recompacted areas done at Contractor’s expense.

E. Tests that are not conducted in the presence of Engineer, or are conducted at locations not selected by Engineer, will be rejected.

3.11 CLEANUP AND RESTORATION

A. Clear site around work area of mud and construction debris.

B. Adjust elevation of existing valve boxes and existing hydrants to surrounding finished grade.

C. Finish graded surfaces with layer of topsoil as specified before.
   1. Minimum depth of topsoil: 8 inches.
   2. Provide a well-compacted, free-draining uniform surface, without obstructive protrusions or depressions.

D. Remove slope protection and erosion control devices in accordance with Owner’s Storm Water Pollution Prevention Plan (SWPPP).

E. Seed fill areas and areas disturbed by construction in accordance with Section 32 92 19.

** END OF SECTION **
SECTION 31 23 16
EXCAVATING, BACKFILLING, AND COMPACTING FOR STRUCTURES

PART 1  GENERAL

1.01 SUMMARY OF WORK

A. Work under this Section includes all excavation, backfilling, and compaction for structures and other miscellaneous excavation, backfilling, and compaction required but not designated under other Sections.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.
B. Section 03 30 00 – Cast-in-Place Concrete.
C. Section 31 22 00 – Site Grading.

1.03 REFERENCES

B. American Society for Testing and Materials
   1. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   2. ASTM D3017 – Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
C. Federal Register – Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards – Excavations.
E. Iowa Statewide Urban Design and Specifications (SUDAS).

1.04 SUBMITTALS

A. Manufacturer’s product literature and samples of geogrid and geotextile fabric demonstrating compliance with Project Specifications.
B. Aggregate quarry certification information demonstrating compliance with Project Specifications.
1.05 MEASUREMENT AND PAYMENT
   A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 IN SITU BACKFILL MATERIAL
   A. Previously excavated soil or material free of organic debris, clay balls, and aggregate larger than 1-1/2 inches as approved by Engineer.

2.02 IMPORTED GRANULAR BACKFILL AND GRANULAR FOUNDATION
   A. Granular subbase material: Crushed limestone, dolomite, or quartzite compliant with Iowa DOT Specification Section 4115, Gradations 3 or 4 for clean drainable subbase.
      1. Install under structural foundations as shown on Drawings.
      2. Engineer may authorize a change in gradation subject to materials available locally at time of construction.

2.03 GEOTEXTILE FABRIC UNDER GRANULAR SUB-BASE
   A. Geotextile fabric – Spunbonded needle-punched polyester or polyethylene fabric conforming to AASHTO M288-96, Service Class 2 with the following minimum properties:
      1. Minimum Weight 5.2 ounces per square yard.
      2. Minimum Tensile Grab Strength equal to 160 pounds.
      3. Minimum Puncture Strength equal to 85 pounds, Trapezoidal Tear equal to 60 pounds.
      4. Grab Elongation equal to 50 percent per ASTM D4632.
      5. Minimum Water Flow Rate equal to 110 GPM per ASTM D4491.

2.04 SUBDRAIN PIPING MATERIAL
   A. Sub-grade Drainage Pipe – Slotted and Un-slotted corrugated polyvinyl chloride pipe with a smooth interior surface.
      1. Pipe and Fittings conforming to ASTM F949 specifications.
      2. Pipe Plastic Material conforming to ASTM D1784 - Cell Class 12454B.
      3. Elastomeric Gaskets conforming to ASTM F477.

PART 3 EXECUTION

3.01 PREPARATION
   A. General Description
      1. The sub-base under the structure is to be free-draining granular foundation fill isolated from native clay with a geotextile fabric barrier enveloping the aggregate within the interior footprint of the building.
      2. Base soil is sloped to drain to slotted sub-drain piping, which in turn discharges to non-slotted pipe that transports drainage to the surface at a lower elevation.

   B. Quality Assurance
      1. Fully isolate free draining aggregate sub-base from surrounding soil to prevent siltation, including banding fabric barrier to pipes or conduits penetrating the envelope.
      2. Compact soil disturbed in the process of grading to 95 percent Standard Proctor Density at or near optimum moisture.
      3. Compact aggregate sub-base to full consolidation with and equivalent density of no less than 95 percent Standard Proctor Density.
C. General Safety
   1. Strictly observe laws and ordinances regulating health and safety measures.
   2. Excavations that Owner’s personnel are required to enter shall comply with OSHA standards.

D. Soil Testing
   1. Complete soil testing in accordance with requirements of Specification Section 31 22 00 Site Grading.

E. Locates
   1. The Contractor shall obtain locates, contacting Iowa One Call prior to performing excavation work.

3.02 EXCAVATION

A. Strip and stockpile topsoil for finished grading.

B. Structural Excavation:
   1. Follow lines and grades as indicated on plans.
   2. Provide uniform bearing on undisturbed soil and continuous support to the greatest extent possible while providing drainage contouring under structural fill.
   3. Prevent over-excavation in locations where suitable subgrade conditions exist.

C. Unstable site conditions, as determined by Engineer, to be corrected as follows:
   1. Over-excavate to stable soil or to a maximum of 2 feet below contoured soil surface under aggregate fill.
   2. If stable soil is reached, backfill using suitable material obtained on site in lifts of 6 inches, compacting each lift to 95 percent Standard Proctor Density.
   3. If suitable soil is not reached within 2 feet, make soil corrections as directed by Engineer. Additional compensation to Contractor for correction work shall be negotiated and agreed upon prior to starting correction work.

D. Remove stones encountered during excavation. Fill voids created through removal of stones with approved backfill material and thoroughly compact to 95 percent Standard Proctor Density. Removal of stones larger than 24 inches in diameter warrants additional compensation to Contractor. Additional compensation shall be negotiated and agreed upon prior to starting large stone removal work.

3.03 DISPOSAL OF EXCAVATED MATERIALS

A. Strip and stockpile topsoil use for finish grading.

B. Incorporate excess native clay materials excavated for structural backfill into site grading materials and distribute over the site as part of grading for the site plan.

3.04 PLACEMENT OF GEOTEXTILE FABRIC

A. Fabric shall form a continuous envelope completely isolating drainable aggregate fill from surrounding soils.

B. Place geotextile fabric continuously over building footprint after grading for drainage, overlapping sides by 12 inches continuously.

C. Place fabric uniformly without wrinkling, gapping, or openings along edges.

D. Band fabric to all pipe or conduits penetrating the fabric envelope using stainless steel hose clamps or minimum 3/8-inch-wide plastic zip ties.
3.05 PLACEMENT OF AGGREGATE BACKFILL

A. Place the initial 6-inch deep aggregate lift on fabric in a way that it anchors and protects the fabric envelope from incidental damage and lightly compact it for consolidation.

B. Place aggregate in lifts of no more than 6 inches, uniformly compacting each lift to full consolidation with a density of no less the 95 percent Standard Proctor.

C. Suitably contain aggregate fill to maintain its compacted state after placement.

3.06 SUBDRAIN PIPE INSTALLATION

A. Pipe is placed in contoured under-slab drainage trenches with slotted pipe on the interior of the building transitioned to non-slotted discharge pipe immediately before it exists the building footprint.

B. Install pipe in the drainage envelop as detailed on Drawings, orienting the slots downward and symmetrically positioned, bedded in a layer of aggregate plus or minus 1 inch in depth.

C. Slope pipe with a 1/4 inch per foot slope toward the discharge pipe.

D. Where pipe passes through concrete, wrap the pipe with a minimum of 1-inch thick closed cell foam extending a minimum of 1 inch beyond the concrete on each side to allow movement in the pipe relative to the footing.

E. Slope discharge pipe 1/4 minimum to a daylight discharge.

F. Protect ends of discharge pipe with manufacturer-provide grates to prevent inhabitation of animals within the pipe.

3.07 PROTECTION

A. Protect pipe and geotextile fabric from tears, punctures, or displacement during placement of aggregate fill.

B. Protect the interior of the geotextile fabric envelope from siltation or contamination with foreign debris during construction. Dirt clumps or materials foreign to the aggregate fill material to be removed completely and voids formed from the removal to be filled with fully consolidated aggregate fill.

3.08 REMOVAL OF WATER

A. Geotechnical investigation of the site determined the site has the intermix permeable and non-permeable stratum of soil creating the likelihood of encountering perched water in excavation operation.

B. Promptly remove water accumulating in the excavated void for the structure in a way that softening of the sub-grade does not take place. Water removal may be done by natural gravity flow drainage or by construction of a sump outside the building footprint and pumping for water removal.

3.09 SAMPLING AND TESTING

A. Compaction of aggregate sub-base and compacted native sub-grade soil will be tested with the use of a nuclear density gauging instrument.

B. Testing standards shall comply with the requirements set forth in Section 31 22 00 Site Grading.
3.10 CLEANUP AND RESTORATION

A. Remove mud, debris, and other remnants from construction activities from site.

B. Remove all geotextile fabric not incorporated into drainage envelope and dispose off site.

C. Prepare edges of the geotextile drainage envelope to properly receive concrete footing placement.

** END OF SECTION **
SECTION 31 23 33
TRENCHING AND BACKFILLING

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Excavating, backfilling, and compacting specifications, as applicable, for installation of water main, buried process piping and plumbing, buried electrical conduit and raceways, buried drainage pipe, and appurtenances.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.
B. Section 31 22 00 – Site Grading.
C. Section 32 92 19 – Seeding.
D. Section 33 14 11 – Ductile Iron and Polyvinyl Chloride Pipe for Buried Piping.
E. Section 33 14 19 – Valves and Hydrants.

1.03  REFERENCES

D. Federal Register – Occupational Safety and Health Administration (OSHA), Occupational Safety and Health Standards – Excavations.
F. Iowa Statewide Urban Design and Specifications (SUDAS).

1.04  SUBMITTALS (NOT USED)

1.05  MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2 PRODUCTS

2.01 EXCAVATED MATERIALS

A. Strip, grub and stockpile topsoil for finished grading.

B. Backfill material to be:
   1. Approved for use by Engineer.
   2. Selected material taken from the excavation or select borrow material, if sufficient quantities of
      compliant excavated material are not available.
   3. Inorganic clays, clayey sands, or inorganic and clayey silts, compatible with and having an
      obtainable density no less than adjacent soils.
   4. Free of lumps or clods over 3 inches in the largest dimension.
   5. Free of foreign debris including rocks, organic materials, and man-made debris.
   6. Material that is not frozen.

2.02 BEDDING MATERIAL

A. Ductile iron pipe, prestressed concrete cylinder pipe, polyvinyl chloride pipe, and corrugated steel
   pipe: Bed pipe using material taken from the excavation with the following characteristics:
   1. Inorganic clay, clayey sand, or inorganic and clayey silt.
   2. Free of lumps or clods over 2 inches in the largest dimension.
   3. Free of foreign debris including rocks, organic materials, and man-made debris.
   4. With a soil moisture range of optimum moisture to 4 percentage points above optimum moisture
      content.
   5. Material that is not frozen.

2.03 STABILIZATION MATERIAL

A. When required by field conditions, stabilization material shall be crushed limestone, dolomite, or
   quartzite generally meeting the following characteristics:
   1. 2-inch nominal maximum size.
   2. 95 percent retained on a 3/4-inch screen.
   3. Generally free from deleterious substances as determined by Engineer.

2.04 BORROW MATERIALS

A. If sufficient suitable material is not available from excavations, obtain material from approved off-site
   sources. Off-site sources must hold a National Pollutant Discharge Elimination System (NPDES)
   permit from the IDNR for storm water discharge associated with construction activity.

B. Borrow material, including topsoil and backfill material, shall conform to specifications for excavated
   materials in Part 2.1.

C. Topsoil borrow material to be:
   1. Natural loam and humus with characteristics consistent with existing topsoil on site.
   2. Finely graded and free of clumps larger than 2 inches in the largest dimension.
   3. Free of man-made materials and debris.
   4. Free of rock or organic matter, including wood and roots, greater than 3/4-inch in the largest
      dimension.
   5. Comprised of less than 0.5 percent clay.
2.05 SPECIAL PIPE EMBEDMENT AND ENCASEMENT MATERIAL

A. When directed by Engineer, install controlled low-strength material to provide support to existing utilities.
   1. Controlled Low-Strength Material (CLSM):
      a. Approximate quantities per cubic yard:
         (1) Cement: 50 pounds.
         (2) Fly ash: 250 pounds.
         (3) Fine aggregate: 2,910 pounds.
         (4) Water: 60 gallons.
      b. A compressive strength of at least 50 psi compressive strength at 28 calendar days.
      c. Comply with material requirements of Section 2506.02 of IDOT Standard Specifications, current version.

PART 3 EXECUTION

3.01 GENERAL

A. General Description
   1. Complete trenching, backfilling, and compacting for water main in accordance with the SUDAS manual. These specifications are intended to highlight or modify basic requirements; see SUDAS manual for more detailed information.

B. Quality Assurance
   1. Provide Engineer with sufficient opportunity to review excavated or borrowed soils prior to placement as backfill.
   2. Owner will commission and compensate a qualified soils engineer to develop Proctor Density curves indicating moisture-density relationships for all soil types used as backfill.
   3. Proctor curves and soil analysis information will be used in determining proper compaction of soils placed.

C. General Safety
   1. Blasting not permitted.
   2. Safety and protection:
      a. Provide shoring, sheeting, and bracing, as required, to protect the Work, adjacent property, private or public utilities, and workers.
      b. Strictly observe laws and ordinances regulating health and safety measures.
      c. Excavations that Owner’s personnel are required to enter shall comply with OSHA standards.

D. Soil Testing
   1. Field tests for density and moisture content to be performed by the soils engineer, defined in Part 3.1.B above, to ensure that specified density is being obtained. Testing to be done using ASTM D2922 nuclear methods or another method approved by Engineer.
   2. Take density tests at finished grade, at 3 feet below finished grade, and as directed by Engineer under special conditions. Test locations to be selected by Engineer immediately prior to performing tests. Excavate, as directed by Engineer, for tests at intermediate depths. As a minimum, take density tests at approximately 200-foot intervals along the trench. Additional tests required at the following locations:
      a. Over jacking pits where casing was installed.
      b. Immediately adjacent to all structures.
   3. When test results indicate compaction is not as specified:
      a. Additional tests will be required in both directions from failed test until satisfactory results are obtained.
      b. Remove all material between the satisfactory tests, replace, and recompact lifts to meet specifications. Compaction corrections to be made at no expense to Owner.
      c. Provide density tests to recompacted areas provided at the same frequency as the original tests. Testing of recompacted areas at the Contractor’s expense.
4. If petroleum-based materials are detected in the soils, the Contractor shall notify Engineer. Appropriate action will be taken by Owner.
5. Tests that are not conducted in the presence of the Engineer, or are conducted at locations not selected by the Engineer, will be rejected.

E. Protection of Utility Lines
1. Conduct trenching operations to avoid damaging underground utilities.
2. Protect underground utilities that are shown on Drawings, located or identified for Contractor prior to trenching. Damage resulting from trenching or backfilling to be repaired by Contractor or utility company at Contractor’s expense.
3. Underground utilities discovered by Contractor shall be protected.

3.02 DISPOSAL OF EXCAVATED MATERIAL

A. Remove excess material excavated for the water main trench from site and in compliance with environmental regulations.

B. Backfill consisting of suitable material, which comes from an off-site source, must conform to Part 2.1.

3.03 TRENCH EXCAVATION

A. Strip and stockpile topsoil for finished grading. A minimum of 12 inches of topsoil must be segregated from other materials in agricultural areas.

B. Excavate trenches so as to:
   1. Follow lines and grades as indicated on Plans.
   2. Provide uniform bearing on undisturbed soil and continuous support along the entire length of pipe.
   3. Prevent over-excavation in locations where suitable subgrade conditions exist.
   4. Provide vertical trench walls to an elevation no less than 12 inches above the pipe.

C. Unstable trench bottoms, as determined by Engineer, to be corrected as follows:
   1. Over-excavate trench to stable soil or to a maximum of 2 feet below bottom of pipe.
   2. If stable soil is reached, bring trench back to grade using suitable backfill material or bedding material compacted to 90 percent Standard Proctor Density.
   3. If stable soil is not reached after 2 feet of over-excavation, place 1 foot of specified trench stabilization material in the trench bottom and compact. Bring trench back to grade using suitable backfill material or bedding material compacted to 90 percent Standard Proctor Density.
   4. Place pipe only after trench bottom has been fully stabilized.

D. Remove stones encountered during excavation. When large rocks are encountered, break away to an elevation 6 inches below the bottom of the proposed improvement. Fill voids created through removal of stones with approved backfill material and thoroughly compacted to 90 percent Standard Proctor Density.

E. Excavate trench bottoms deeper at location of bell joints to permit body of pipe to rest uniformly supported upon the trench bottom. Use bell holes no longer than is necessary for practical installation of pipe.

F. Length of trench to be opened at one time as follows:
   1. In extended runs, open trench length shall not exceed 100 feet.
   2. In street crossings, trench shall not be open in more than one lane at a time, unless specified differently in traffic control plan.
   3. Backfill driveways and entrances immediately after placement of pipe.
G. Excavated material to be placed:
   1. As approved by Engineer when these specifications do not apply.
   2. Compactly along sides of excavation.
   3. To provide continuous access to fire hydrants and utility valves.
   4. To provide as little inconvenience as possible to public travel.
   5. To minimize damage to adjacent lawns and planted areas.

3.04 PIPE BEDDING

A. Bed all pipe with 4-inch thick layer of specified bedding material.

B. Place bedding alongside of pipe to an elevation above springline (no lower than half the height of the pipe).

C. Compact bedding to a minimum of 90 percent Standard Proctor Density.

D. Obtain required compaction within a soil moisture range of optimum moisture to 4 percentage points above optimum moisture content.

E. Do not damage pipe coating or wrapping system during bedding placement and compaction.

3.05 BACKFILLING

A. Backfill trenches only after pipe installation, jointing, and bedding are complete, inspected, and approved.

B. Backfill material shall comply with Part 2 above.

C. Mechanically tamp backfill with impact or vibrating compaction equipment.

D. Place backfill in layers and compact to required density.

E. Backfill to be:
   1. Compacted to:
      a. 90 percent Standard Proctor Density to a level one (1) foot above pipe.
      b. 95 percent Standard Proctor Density for remainder of the trench.
   2. Within a soil moisture range of optimum moisture to 4 percentage points above optimum moisture content.

F. Protect pipe coating or pipe wrapping system from damage during backfill operations.

G. Hydraulic compaction or water jetting of pipe trenches not permitted.

H. Adjust moisture content of material that exceeds optimum moisture range, but is otherwise acceptable, by spreading and aerating or otherwise drying as necessary until moisture content is within required moisture range and required compaction can be obtained.

I. Adjust moisture content of material that is below optimum moisture, but is otherwise acceptable, by wetting as necessary until moisture content is within required moisture range and required compaction can be obtained.

3.06 GRADING

A. Finish-grade surfaces with a well-compacted, free-draining, uniform surface without obstructive protrusions or depressions.

B. Place topsoil at a uniform depth equal to surrounding topsoil, but not less than 4 inches.
C. Place topsoil to a minimum depth of 6 inches when ample native topsoil is available.

D. Place topsoil only under lawn and planted areas.

3.07 CONTROL OF WATER

A. Install pipe in the dry.

B. Dewater as necessary to prevent water from entering pipe or rising around pipe.

C. Do not allow water pumped or diverted from excavation site to:
   1. Pool anywhere on site.
   2. Be removed in such a manner as to disperse silt.
   3. Be placed on surfaces heavily traveled by pedestrian traffic.

D. Do not use installed pipe as a conduit for trench dewatering.

E. Control surface water as follows:
   1. Divert surface water to prevent entry into pipe trenches.
   2. Remove surface water accumulated in pipe trenches and other excavations prior to continuation of excavation work.
   3. Remove surface water saturated soil from the excavation.

F. Control groundwater as follows:
   1. Where groundwater is encountered, dewater trenches and other excavations, as necessary, to permit proper execution of the Project.
   2. When large quantities of groundwater are encountered, stabilize trenches with specified stabilization material, and bed pipe as specified.

G. Allow Engineer opportunity to inspect any foundation excavations or pipe trenches exposed to rain or surface water infiltration.
   1. Implement corrective measures prescribed by Engineer.
   2. Do not backfill until corrective measures have been reviewed by Engineer.

3.08 DISPOSAL OF UNSUITABLE OR EXCESS MATERIAL

A. Dispose of surplus material and material not suitable for backfill off-site at a location provided by Contractor.

B. Off-site disposal locations must hold a National Pollutant Discharge Elimination System (NPDES) permit from the IDNR for storm water discharge associated with construction activity.

C. Transportation of such material shall be provided by Contractor.

3.09 CLEANUP AND RESTORATION

A. Remove mud, debris, and other remnants from construction activities from site.

B. Complete seeding in accordance with Section 32 92 19.

C. Damage to adjacent property suffered during installation work to be repaired to a condition equal to, or better than, that existing prior to trenching work.

** END OF SECTION **
PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Work includes construction of granular surfacing driveway and concrete sidewalk and driveway as shown on the Drawings.

B. Contractor to design and construct temporary access drive needed for construction. Remove temporary access road at the end of construction.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 03 30 00 – Cast-in-Place Concrete.

1.03  REFERENCES


B. Iowa Department of Natural Resources (IDNR) Iowa Construction Site Erosion Control Manual, Current Edition.

C. Iowa Department of Transportation (IADOT), English Standard Specifications for Highway and Bridge Construction, Current Edition.


1.04  PERFORMANCE REQUIREMENTS

A. Perform Work in accordance with SUDAS Section 7010 – Portland Cement Concrete Pavement.

1.05  SUBMITTALS

A. Submit in accordance with Specification Section 01 00 00.

B. Submit layout of proposed temporary access road.

C. Submit such product literature and catalog cuts to relate the materials supplied to these Specifications.

1.06  MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
**PART 2  PRODUCTS**

### 2.01 GRANULAR SURFACING

A. Temporary surfaces: Contractor’s discretion and choice.

B. Permanent Granular Surfacing:
   1. Granular surfacing for access road: Mineral aggregate meeting requirements of Section 4120 of the Iowa Department of Transportation (IDOT) Standard Specifications for Highway and Bridge Construction. Gradation must comply with gradation number 11.
   2. Aggregate for granular surface base course: Mineral aggregate meeting requirements of Section 4123 of the Iowa Department of Transportation (IDOT) Standard Specifications for Highway and Bridge Construction. Gradation must comply with gradation number 14.

### 2.02 SUBGRADE STABILIZATION POLYMER GRID (GEOGRID)

A. Subgrade Stabilization Polymer Grid (Geogrid):
   1. Subgrade stabilization polymer grid according to Iowa Department of Transportation (IDOT) Standard Specifications.
   2. Roll width: 16 feet.

### 2.03 PORTLAND CEMENT CONCRETE

A. Concrete Mix: Iowa Department of Transportation (IDOT) Standard Specifications Class C-4 WR-C20, air-entrained. Comply with requirements of Materials I.M. 529 and ASTM C94.
   1. Ensure compatibility of all material combinations.
   2. Maximum water / cement ratio: 0.43.
   3. Minimum compressive strength: 4,000 psi at 28 days.

B. PCC Mix to comply with the following:
   1. Slump Range:
      b. Hand Finished: 1/2 inch to 4 inches.
   2. Air content:
      a. Machine Finished: Target 8 percent plus or minus 2 percent.
      b. Hand Finished: Target 7 percent plus or minus 1-1/2 percent.

### 2.04 PCC BASE MATERIAL

A. Material: Conforming to Section 4121 of Iowa Department of Transportation (IDOT), English Standard Specifications for Highway and Bridge Construction.

B. Base Material Thickness: 6-inch minimum.

### 2.05 REINFORCING STEEL

A. Smooth dowel bars in accordance with ASTM A615.

B. Epoxy-coated in accordance with Section 4151 of Iowa DOT Standard Specifications.

C. Dowel setting epoxy: Two-part epoxy providing minimum 9,000-pound pullout after 7 days. Approved manufactures Sika Corporation, Sikadur 31 Hi-Mod Gel, or approved equal.
2.06 JOINT MATERIALS

A. Pre-formed Expansion Joint Filler: Self-expanding resilient filler meeting the requirements of Section 4136 of Iowa DOT Standard Specifications.

B. Joint Sealer: Hot-poured petropolymer meeting the requirements of Section 4136 of Iowa DOT Standard Specifications.

C. Backer Rod: Closed-cell urethane foam meeting the requirements of Section 4136 of Iowa DOT Standard Specifications.

2.07 CURING COMPOUND

A. Membrane-Forming Curing Compound compliant with ASTM C309, Type 2; white pigmented.

PART 3 EXECUTION

3.01 PREPARATION

A. Provide for surface and storage drainage of roads, parking, staging, and adjacent areas.

B. Remove vegetation and roots from ground surface.

C. Prepare foundation by excavating to lines, grades, and cross section as required.

D. Remove all soft, spongy, or yielding spots and fill voids with suitable backfill material.

3.02 GRANULAR SURFACING

A. Temporary Access Road:
   1. Design and construct temporary access road to serve construction areas; provide for sufficient width and load-bearing capacity to support traffic and equipment Contractor deems necessary for construction purposes.
   2. Install temporary culverts to span low areas and allow unimpeded drainage, where necessary.
   3. Use of granular material or engineered geotextile fabric for surfacing of temporary access road at Contractor’s discretion.
   4. Always keep temporary access road and construction equipment within limits of construction areas.
   5. Remove temporary access road at end of construction.

B. Permanent Access Road:
   1. General:
      a. Construct permanent access road after majority of construction work, which could cause mud to be tracked on access road surface, has been completed.
      b. Locate alignment and boundary of permanent access road for review and approval of Engineer.
      c. Provide smooth transitions in alignment of access road and parking areas and at access road intersections.
      d. Grade and shape crowned cross-section for access road subgrade.
      e. Provide subgrade with smooth, firm, free-draining surface free from foreign material that may damage geotextile fabric.
      f. Allow Engineer to review road subgrade prior to placement of geogrid fabric. Correct deficiencies identified by Engineer.
   2. Subgrade Stabilization Polymer Grid (Geogrid):
      a. Place geogrid fabric in accordance with manufacturer’s recommendations.
      b. Stretch geogrid fabric on subgrade to remove all wrinkles. Use galvanized staples provided by manufacturer, if necessary, to secure geogrid.
      c. On curves, cut or fold and staple geogrid as recommended by manufacturer.
d. Overlap geogrid in direction that granular surfacing will be placed and spread. If necessary, secure overlaps with stakes or nails spaced at approximately 2 feet.
e. Allow Engineer to review geotextile fabric installation prior to placement of granular surfacing material. Correct deficiencies identified by Engineer.

3. Granular Surfacing:
   a. Place granular surfacing base course material on geogrid in manner that will not damage the subgrade or the geogrid fabric. Review method of placement with Engineer before commencing placement of material. Placing material from a dump truck while backing up will be an acceptable method of placement.
   b. Place granular surfacing for access road on top of granular surfacing base course in a manner that will not damage the base. Review method of placement with Engineer before commencing placement of material.
   c. Do not drive vehicles directly on geogrid until after at least 3-inch thick layer of granular material has been placed.
   d. Spread and shape granular material using wide-track bulldozer to provide thickness and cross-section shown on Plans.
   e. Compact granular surfacing with smooth steel drum roller.

4. Avoid driving vehicles off edge of permanent access road after granular surfacing has been placed, shaped, and compacted. Repair road edges damaged by construction activity.
5. Prevent mud from contaminating granular surfacing placed on permanent access road and parking areas.
6. Provide unimpeded access for Owner and emergency vehicles during access road construction.

3.03 PCC BASE MATERIAL - INSTALLATION
   A. All work to be completed in accordance with Iowa Statewide Urban Design and Specifications (SUDAS).
   B. Subgrade preparation:
      1. Verify subgrade has been properly compacted and meets the requirements of SUDAS Section 2010.
      2. Trim the subgrade or subbase to fine grade for placement of concrete.
   C. Install a minimum of 6 inches of compacted aggregate base course or granular subbase material under all sidewalks and driveways.

3.04 PCC SIDEWALK AND DRIVEWAYS
   A. Install according to SUDAS Section 7010.
   B. Construct sidewalks to a depth of 4 inches except where meeting road or driveways where they shall be constructed to a depth of 6 inches, unless otherwise noted on the Drawings.
   C. Slope sidewalks at 1/4 inch per foot away from the building.
   D. Construct driveways to a uniform depth of 6 inches, unless otherwise noted on the Drawings.

3.05 PCC FINISHING
   A. Finish all exterior concrete with a medium broom finish.
   B. Apply membrane-forming curing compound immediately after finishing concrete. Form a continuous film of curing compound over the entire exposed surface, producing an all-white surface showing no gray concrete when complete.

3.06 PCC JOINTING
   A. Construction, transverse, longitudinal, and isolation joints shall be according to SUDAS Section 7010.
B. Saw joint within 12 hours of placement with a 1/8-inch saw blade to a depth of 1/3 of the pavement thickness.

C. Joint Spacing:
   1. Sidewalk:
      a. Transverse joints spacing equal to the width of the sidewalk.
      b. Panel largest dimension shall be no more than 2 times the least dimension.
   2. Driveway:
      a. Panel dimensions shall not exceed 12 feet in any direction.
      b. Panel largest dimension shall be no more than 1-1/2 times the least dimension.

3.07 MAINTENANCE

A. Maintain temporary and permanent surfaces in sound condition.

B. Keep temporary and permanent surfaces free of excavation material, construction equipment, mud, snow and ice.

C. Properly repair potholes, low areas, standing water, and other deficiencies in temporary and permanent surfaces.

3.08 CLEANING

A. Remove temporary access drive and temporary drainage measures at the end of the project.

B. Remove mud and other construction debris from construction areas.

** END OF SECTION **
SECTION 32 31 13
CHAIN LINK FENCE AND GATES

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Furnish all materials, equipment, and labor necessary to install chain link fence and one (1) passage gate at the locations shown on the Drawings and as specified herein.

B. Furnish all materials, equipment, and labor necessary to install one (1) cantilever, single leaf, manual slide gate system.

1.02  RELATED SECTIONS

A. Section 03 30 00 – Cast-in-Place Concrete.

B. Section 32 13 10 – Sidewalks, Driveways, and Temporary Access.

C. Section 32 22 00 – Site Grading.

1.03  REFERENCES


N. Iowa Statewide Urban Design and Specifications.
1.04 SUBMITTALS

A. Submit manufacturer’s certification that materials furnished are in compliance with applicable requirements of the referenced standards and this Specification.

B. Provide dimensional drawings, fabrication details, functional description, and properly identified catalog data on items to prove complete compliance with Drawings and Specifications.

1.05 MEASUREMENT AND PAYMENT (NOT USED)

PART 2 PRODUCTS

2.01 MATERIALS

A. Comply with SUDAS Section 9060 – Chain Link Fence – Part 2 – Products:
   2. Fence without barb is 8-foot height.

2.02 COMPONENTS (SLIDE GATE)

A. Components
   1. Width: 24-foot clear as shown on Drawings.
   2. Counter-balance length: One-half the width of the leaf-opening length.
   3. Height: 8-foot.
   4. Sliding mechanism
      a. Enclosed.
      b. Two-piece track and frame.
      c. Roller assembly operates on interior of track.
      d. Roller bearings: vertical support.
      e. Nylon idler rollers: horizontal support.
      f. Two roller assemblies per gate minimum.
      g. Finish: Black vinyl coating.
   5. Framing
      a. Pipe ASTM F1083.
      b. Aluminum = 6063 TS.
      c. Welded gate frame.
      d. 2-inch-square tube 0.94 pounds per foot.
      e. Finish: Black vinyl coating.
   6. Slide gate support post:
      a. 4-inch OD Schedule 40 9.1 pounds per foot.
      b. Galvanized with black vinyl coating.
      c. Concrete footings, minimum 4.5-foot depth, 24-inch outside diameter.

2.03 COMPONENTS (SWING GATE)

A. Refer to SUDAS Drawing Sheet 9060.102 and related SUDAS specifications:
   1. Width: 3-foot clear as shown on Drawings.
   2. Height: 8-foot.
   3. Finish: Black vinyl coating.
PART 3 EXECUTION

3.01 GENERAL INSTALLATION

A. Install framework, fabric, accessories, and gates in accordance with ASTM F567 and per manufacturer’s instructions.

B. Place fabric on outside of posts and rails.

C. Set posts plumb in concrete footings with top of footing 2 inches above finished grade. Slope top of concrete footing for water drainage.

D. Line post footing depth below finish grade: 42 inches.

E. Corner, gate, and terminal post footing depth below finish grade: 54 inches.

F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail one bay from end and gate posts.

G. Install top rail through line post tops and splice with 6-inch-long rail sleeves.

H. Install center and bottom brace rail on corner gate leaf.

I. Do not stretch fabric until concrete foundation has cured 7 days.

J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

K. Position bottom of fabric 2 inches above finished grade.

L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 12 inches on center.

M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.

N. Install bottom tension strap stretched taut between terminal posts.

O. Install support arms sloped outward and attach barbed wire; tension and secure.

P. Install passage gate with fabric and barbed wire overhang to match fence. Install two hinges per leaf. Provide latch, catches, torsion-spring retainer, retainer, and locking clamp.

Q. Slide Gate Installation

1. Slide gate system to be installed in strict accordance with the company’s printed instructions, unless otherwise shown on the Contract Drawings.

2. The gate and installation shall conform to ASTM F1184 standards for aluminum cantilever slide gates, Type II, Class 2.

** END OF SECTION **
SECTION 32 92 19
SEEDING

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Materials, equipment, tools, labor, and performance of work for seeding, as specified below.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.
B. Section 31 11 00 – Clearing and Grubbing.
C. Section 31 22 00 – Site Grading.
D. Section 31 23 33 – Trenching and Backfilling.

1.03  REFERENCES

B. Iowa Statewide Urban Design and Specifications (SUDAS).

1.04  SUBMITTALS

A. Submit certificate of compliance from seed supplier stating materials comply with requirements of these Specifications.
   1. Submit certification to Owner that all seed to be used is in compliance with the following:
      b. Species type and pounds of pure live seed (PLS) certification.
      c. Date and results at germination and purity tests.
      d. Test date to determine that percentages of germination and purity tests have been completed within a 9-month period, exclusive of the calendar month in which the test was completed.
      e. The seed analysis on the label shall be mechanically printed.
      f. Certification that seed source is Iowa origin Yellow Tag seed.
   2. Supply to Owner verification of weight of mulch delivered to jobsite in a method satisfactory to Owner.

B. Provide proof of fertilizer chemical analysis and weight to Engineer.

C. Submit proof of capability to adequately apply water at rates required in this Section.

D. Submit water-usage records for each day's watering to Engineer.

1.05  MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2 PRODUCTS

2.01 GENERAL
A. In addition to the following provisions, comply with Section 9010, Iowa Statewide Urban Design and Specifications (SUDAS).
B. Provide commercial grades of types specified; meet requirements of the State of Iowa.
C. Label all seeding materials delivered to jobsite according to U.S. Department of Agriculture Federal Seed Act. Furnish in containers with tags showing seed mixture, purity, germination, weed content, name of seller, and date on which seed was tested.
D. Deliver seeding materials to site in original containers. Do not mix or blend except in the presence of the Owner.
E. Test for germ and purity by accepted methods within a period of 9 months prior to delivery.
F. Do not use moldy seed or seed that has been damaged in storage. Use previous season seed crop only.

2.02 SEED MIXTURE
A. Type 1 (Permanent Lawn Mixture) per Iowa Statewide Urban Design and Specifications (SUDAS).

2.03 SEED QUALITY
A. Meet or exceed purity and germination requirements for Iowa Yellow Tag seed.

2.04 FERTILIZER
A. Fertilizer: granular form. Deliver to site in original bag in good condition for proper distribution.
B. Provide proof of chemical analysis and weight to Engineer.
C. Granular fertilizer in bulk form or liquid fertilizer may be supplied in lieu of bagged fertilizer. Deliver fertilizer with proper scale weight records and a statement of guaranteed analysis by the fertilizer supplier.
D. Comply with rules of the Iowa Department of Agriculture.

2.05 MULCH
A. Conventional Seeding:
   1. Mulch material: straw (oats, wheat, barley, or rye). Do not use hay, Brome grass, Timothy, Orchard grass, Alfalfa, or Clover to mulch areas where lawn mixtures are seeded, but these may be used to mulch areas where erosion control and perennial ground covers are seeded.
   2. Other materials may be used, subject to approval in writing of the Owner.
   3. Use mulch of clean, air-dry straw that has been properly cured and harvested. Mulch harvested after a killing frost or during dormant periods will not be acceptable. Do not use mulch that is rotted, brittle, moldy, caked, or otherwise degraded.
   4. Keep mulch free of weeds as published by the County Weed Commissioner and other weeds deemed undesirable by the Owner, such as foxtail.
   5. Subject each load of mulch to inspection and acceptance by Owner prior to unloading.
   6. At least 50 percent of the salvage weight of each mulch bale shall contain mulch with a length of 10 inches or greater. This requirement applies to all mulch intended for crimping into the sown seedbed.
B. Hydraulic Seeding:
   1. Mulch material: natural or cooked cellulose fiber, processed from whole wood chips (no recycled material) capable of being applied with standard hydraulic mulching equipment.
   2. Use green dye for mulch to facilitate visual metering during application.
   3. Package mulch in new labeled containers and apply at a rate of 1,800 pounds per acre (4.13 lb/sq).

2.06 TACKIFIER (HYDRAULIC SEEDING)
A. Include a Colloidal Polysaccharide Tackifier to prevent separation during shipment and avoid chemical agglomeration during mixing within hydraulic mulching equipment.
B. Keep material homogeneous within the slurry.
C. Apply at a minimum rate of 50 pounds per acre (0.11 lb/sq).
D. Package tackifier in new labeled containers.

2.07 INOCULANT FOR LEGUMES
A. Provide an inoculant consisting of a culture of bacteria specifically formulated for legume seeds (alfalfa, clovers, lespedezas, bird's-foot, trefoil, hairy vetch, and crown vetch).
B. Indicate on manufacturer's container the specific legume seed to be inoculated and the expiration date.
C. Meet requirements of the Iowa Seed Law.

2.08 FUNGICIDE
A. Fungicide: non-mercurial protectant formulation to provide protection from soil-born fungus diseases of seeds.
B. Apply fungicide at the rate of 5-1/2 ounces of a 75 percent concentrate, or equivalent, per 100 pounds of seed.

2.09 STICKING AGENT
A. Sticking Agent: Commercial material recommended by manufacturer to improve adhesion of inoculant and fungicide to the seed.
B. For small quantities, less than 50 pounds:
   1. Sticking agent need not be a commercial agent, but it must be approved by Engineer.
   2. Apply sticking agent separately prior to application of inoculant and fungicide.

2.10 WATER
A. Use potable water.
B. Use of non-potable water sources must be approved by Owner.
PART 3  EXECUTION

3.01  GENERAL

A. In addition to the following provisions, comply with Section 9010, Iowa Statewide Urban Design and Specifications (SUDAS).

B. Job Conditions
   1. Conform to construction limits shown on Drawings.
   2. Seedbed preparation by mechanized equipment to be performed by Contractor on all areas as shown on Drawings disturbed by excavation, grading, and other construction procedures in accordance with the requirements of this Section.
   3. Perform seeding only during seasons specified. Do not perform seeding operations during times of drought, excessive moisture, or other unfavorable climatic conditions.
   4. Prior to the work of this Section, carefully inspect installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
   5. Do not proceed with installation in areas of discrepancy until all discrepancies have been fully resolved.

C. Quality Assurance
   1. Qualifications of Workers: Provide at least one person who shall be present at all times during execution of this portion of the Work and who shall be thoroughly familiar with type of materials being installed and best methods for their installation, and who shall direct all work performed under this Section.
   2. All seed shall meet or exceed requirements contained in this Section and federal, state, and county laws requiring inspection for plant disease and insect control and be labeled and certified in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and Iowa State laws. All seed must be dated for test and be from the last season prior to date of delivery.
   3. Use mulch meeting the requirements of Part 2 of this Section and not containing weeds. The Contractor shall identify to Owner the locations from which the straw mulch was obtained and prove weight.
   4. The Owner reserves the right, at any time, to sample all materials for testing to determine compliance with the requirements of this Section.

D. Delivery, Storage, and Handling
   1. Storage of all materials on the jobsite must be approved in writing in advance by Owner.
   2. Materials approved for storage on site which, in the opinion of the Owner, are being degraded due to storage must be removed and replaced at no additional cost to Owner.
   3. Use all means necessary to protect materials from the elements during delivery, handling, and storage.
   4. Deliver packaged materials to site in supplier’s original unopened containers; each container to bear certification as specified. Pure live seed (PLS) certification shall be attached to all seed containers and shall not be removed except by Owner.
   5. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
   6. Store packaged materials off ground and protect from moisture. Moisture-damaged materials are unacceptable. Wet, moldy, or otherwise damaged seed is unacceptable.
E. Site Disturbances
   1. Take precautions to ensure that equipment and vehicles do not unnecessarily disturb or damage existing grading, other site improvements, or adjacent areas to the Work.
   2. Repair damage and return site and adjacent areas disturbed by Contractor’s operations to original condition at no cost to Owner.

F. Comply with regulatory agencies for fertilizer and herbicide composition.

3.02 INITIAL PREPARATION

A. In those areas where grading is permitted, perform and complete final grading prior to initiating work of this Section in any area.

3.03 SEEDBED PREPARATION

A. Smooth areas to be seeded.

B. Fill washes and gullies to conform to desired cross sections and contours.

C. Thoroughly disk areas accessible to field machinery to a depth of not less than 3 inches.

D. Thoroughly chop weed growth, cut with a rotary or flail mower, and disk weed residue into soil.

E. Prepare areas inaccessible to field machinery by hand to a depth of not less than 1-1/2 inches after the required fertilizer has been applied.

3.04 APPLICATION OF FERTILIZER

A. Spread uniformly to areas to be seeded at the minimum rate specified.

B. Till fertilizer into soil according to Part 3.5.

C. Spread with a mechanical spreader or sprayer that will secure a uniform rate of application.

D. Areas Accessible to Machinery: Spread fertilizer after the area to be seeded has been filled and smoothed to desired cross section and thoroughly disked, but prior to combined tillage and rock-removal operations.

E. Areas Inaccessible to Machinery: Spread fertilizer prior to preparation of the seedbed and uniformly mix in the top 1-1/2 inches.

F. Contractor permitted to substitute other fertilizer, containing analysis percentages differing from those specified, under the following conditions:
   1. Minimum quantities of actual Nitrogen (N), Phosphate (P), and Potassium (K) per acre are supplied.
   2. Do not exceed total quantities, per acre of the three fertilizer elements N, P, or K, by 30 percent of the following minimum quantities:
      a. Hydraulic Seeding:
         (1) Apply 6-24-12 commercial fertilizer or the equivalent units of (N), (P), and (K) at the rate of 100 pounds per acre (0.92 lb/sq) prior to seeding.
         (2) In addition to the above, apply a minimum of 100 pounds per acre (0.46 lb/sq) of a 20-26-6 fertilizer in which a minimum of 50 percent of the total nitrogen is Water Insoluble Nitrogen as part of the seed, fertilizer, mulch, and water slurry.
      b. Conventional Seeding:
         (1) Apply fertilizer over areas at rate designated on plans or in specifications.
         (2) Unless stated otherwise, apply 16-16-16 fertilizer, or equivalent, at the rate of 150 pounds per acre.
   3. Approved by Engineer.
3.05 **TILLING**

A. After fertilizer has been applied, remove rocks and solid non-soil material larger than 1-1/2 inches in diameter from the upper 3 inches of the soil.

B. Smooth seedbed with a cultivator-type tillage tool immediately prior to seeding.

3.06 **SEED PREPARATION**

A. Inoculate legumes with a standard product humus culture before mixing with other seeds for sowing.

B. Do not expose inoculated seed to direct sun for a period of time exceeding 1/2 hour.

C. Reinoculate seed that is not sown within 8 hours after inoculation.

D. Legumes (except Crown Vetch and Bird's-foot Trefoil): Inoculate at two times the rate specified by the manufacturer of the inoculant.

E. Crown Vetch and Bird's-foot Trefoil: Inoculate at five times the rate specified by the manufacturer of the inoculant.

F. Preinoculated seed will be considered as inoculated at not more than one times the rate specified by the inoculant manufacturer. Additional inoculation required on preinoculated seed to comply with the above specifications.

3.07 **APPLICATION**

A. Seeding Dates:
   1. Normal spring seeding dates: March 1 – May 31.
   2. Normal fall seeding dates: August 10 to September 30.
   3. Dormant seeding dates: November 1 – March 1 only with permission of Engineer.
   4. Legumes, including Crown Vetch: Seed only during the spring season prior to April 15.

B. Conventional Seeding:
   1. Areas accessible to field machinery: Sow grasses with a drop-type seeder attached to a landscape roller so that seed is applied and then covered by rolling, which firms the soil. Roll areas seeded by a hydraulic seeder with a cultipacker-type roller immediately after seeding.
   2. Areas inaccessible to field machinery:
      a. Use of cyclone seeders will be permitted. No other hand-seeding methods will be accepted without approval by Engineer.
      b. Grass and legume seed used with hand seeders on early spring work must be performed as separate operations. Mixing of the two types of seed will not be permitted.

C. Hydraulic Seeding:
   1. Place material, seed, fertilizer, mulch, and tackifier in hydraulic mulching equipment specifically manufactured for hydraulic mulching.
   2. Mix materials with fresh potable water using a combination of both recirculation through the equipment's pump and mechanical agitation to form a homogeneous slurry.
   3. Apply evenly over specified areas at component material rates specified.
   4. Remove hydraulic mulch slurry from buildings, landscaping, sidewalks, and other areas not specified for application.
   5. Remove debris from site.
3.08 MULCHING

A. Mulch seeded areas as soon as seed is sown.
B. Uniformly distribute mulch over required areas at a rate of 2 tons of dry mulch per acre.
C. Work mulch into soil with tucker designed to anchor mulch into soil by means of dull blades or disks.

3.09 WATERING

A. Keep seeded areas moist at all times. Use quantity of water adequate to keep soil and mulch moist and ensure growth of seed.
B. First week after seeding is completed: Artificially water seeded areas, every day, a minimum of twice a day (early morning and evening).
C. Second and third weeks after seeding: Artificially water seeded areas, every day, once a day (early morning or evening).
D. Adjust artificial watering in conjunction with natural rainfall.
E. Maintain area seeded in the month of May for an additional 3 weeks. Apply a minimum of one (1) inch of water each week (either natural, artificial, or a combination) for the fourth, fifth, and sixth weeks to seeded areas after seeding.
F. In areas approved by Engineer for dormant seeding, watering will not be required until soil temperatures reach the level required for seed germination.
G. Submit proof of capability to adequately apply water at the rates required above.
H. Submit water-usage records for each day's watering to Engineer.

3.10 MAINTENANCE

A. Protect seeded areas from damage due to trespassers and operations of other contractors and trades. Commence maintenance immediately following seeding operations and continue until the Owner has issued final acceptance of the Project. Repair or replace damaged areas.
B. Reconditioning Existing Areas:
   1. Remove Contractor's equipment, project materials, and wastes such as oil drippings, stones, gravel, and packaging containers, from site or dispose of in a manner approved by Owner.
   2. Recondition and plant all disturbed areas including areas outside grading limits, such as entrance and haul roads, according to this Section.
C. Repairs:
   1. Repair all areas of rill erosion with a depth of greater than 3 inches and width greater than 4 inches.
   2. Repair defects in vegetation having individual bare areas greater than one (1) square foot or total bare areas exceeding 2 percent of the entire vegetated area.
   3. The costs of materials and labor for repairs are at no additional cost to Owner.

3.11 MINIMUM REQUIREMENTS FOR ACCEPTANCE

A. Ninety (90) days following evidence of plant growth or greenup, Owner and Contractor shall inspect and evaluate seeded areas for acceptance based on criteria listed below.
B. The plant growth shall provide a minimum of 75 percent cover over the seeded area. Interseed or reseed areas failing to meet this cover density as required by Owner, at no cost to Owner.
C. All plants included in the seed mixture must be present in the vegetation stand growing on site. If a species is nearly or totally absent from the vegetation stand, Owner will require Contractor to interseed the missing species at no cost to Owner.

D. Following repair of defects, unaccepted areas, and reseeding, the repaired areas will again be inspected 90 days after evidence of plant growth or greenup. Evaluate these areas using the criteria listed in this Section.

E. In the event that in either the original seeding or repair seeding it is found that the work, materials, or seedbed preparation failed to meet quality or application rates specified, additional work shall be required at no cost to Owner.

3.12 WARRANTY

A. Guarantee seeding through one (1) full year after seeding is completed and accepted by Owner.

B. Seeded areas shall be in a live, healthy, and growing condition at the end of the warranty period.

C. During warranty period, correct any defects in finish grading and seeding work. Repair damage to property resultant from such defects and damage resultant from remedying these defects without additional expense to the Owner.

** END OF SECTION **
PART 1  GENERAL

1.01 SUMMARY OF WORK
A. Disinfect water mains and appurtenances in accordance with this Section.
B. Disinfection of indoor Process Piping and Valves.

1.02 RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 31 23 33 – Trenching and Backfilling.
C. Section 33 14 11 – Ductile Iron and Polyvinyl Chloride Pipe for Buried Piping.
D. Section 40 05 56 – Process Valves and Specialties.
E. Section 40 23 23 – Process Piping and Specialties.

1.03 REFERENCES
A. American Water Works Association (AWWA) B300 – Hypochlorites.
B. American Water Works Association (AWWA) B301 – Liquid Chlorine.
C. American Water Works Association (AWWA) C651 – Disinfecting Water Mains.

1.04 SUBMITTALS (NOT USED)

1.05 MEASUREMENT AND PAYMENT
A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2  PRODUCTS

2.01 CHLORINE
A. Calcium hypochlorite granules conforming to AWWA B300.
B. Liquid chlorine conforming to AWWA B301.

2.02 DE-CHLORINATION CHEMICALS
A. Vita-D-Chlor (Ascorbic Acid) by Integra Chemical Company.
B. Vita-D-Chlor, Neutral (Sodium Ascorbate) by Integra Chemical Company.
C. No-Chlor (Ascorbic Acid) by Measurement Technologies.
D. Approved equal.
PART 3 EXECUTION

3.01 EXAMINATION

A. Water for disinfection will be provided by Owner for two disinfection attempts. If additional attempts are necessary, the Contractor will be billed for water used at the normal rate set for industrial customers.

B. Perform disinfection of piping only after satisfactory pressure testing has been achieved.

C. Ensure piping to be disinfected is isolated from portion of distribution system that is in service.

D. Review procedures and coordinate disinfection with Owner.

E. Perform Work in accordance with AWWA C651.

F. Owner to take bacteriological samples and test to ensure satisfactory disinfection.

3.02 CHLORINATION OF PIPING

A. Provide equipment and materials necessary to complete chlorination.

B. Use continuous feed method as outlined in AWWA C651.

C. Prior to feeding chlorine, fill and flush new piping to remove trapped air and particulates. Provide equipment and materials necessary to obtain a minimum flushing velocity of 3.0 feet per second in piping to be disinfected. When flushing velocities of 3.0 feet per second cannot be obtained, swab pipe until pipe is free of debris. Owner to approve type of swab and procedures for use prior to its use.

D. Induce flow of potable water through new piping at required flushing velocity. Make provisions for diverting and disposing of flushing water that does not damage surroundings. Repair damage caused by flushing activities.

E. At a point within five pipe diameters of connection to the existing distribution system, introduce highly chlorinated water in sufficient quantity to provide at least 25 mg/L free chlorine in the new piping. Provide all metering and feed equipment and temporary chlorination taps. Remove temporary chlorination taps and cap the pipe once the pipe passes.

F. Introduce highly chlorinated water continuously until entire section of new piping contains a minimum of 25 mg/L free chlorine. Do not exceed 100 mg/L free chlorine.

G. Isolate newly chlorinated piping for a contact period of at least 24 hours, and not more than 48 hours, taking care not to backflow chlorinated water into the existing potable water system.

H. After the contact period, water in new piping must have a residual-free chlorine content of not less than 10 mg/L. If residual is less than 10 mg/L, rechlorinate as outlined above.

3.03 FLUSHING CHLORINATED PIPING

A. After the contact period, flush recently chlorinated piping with potable water.

B. Continue flushing until chlorine residual in new piping is equal to chlorine residual in existing distribution system.

C. Isolate new piping from existing distribution system for a period of not less than 24 hours.
3.04 BACTERIOLOGICAL TESTING

A. Immediately following flushing of pipelines and again at least 24 hours after flushing pipelines, samples will be taken and tested by Owner.

B. The Owner reserves the right to take and test additional samples 48 hours after flushing.

C. Approximately one sample will be taken for each 1,200 feet of new water main.

D. Additional samples may be taken at discretion of Owner.

E. Samples must show the absence of coliform organisms and other contaminants and meet requirements of the Iowa Department of Natural Resources to be considered acceptable.

F. If any sample is not satisfactory with either sampling, piping represented by that sample must be flushed and rechlorinated by Contractor at the discretion of, and as directed by, the Owner.

** END OF SECTION **
SECTION 33 01 12.10
PRESSURE TESTING WATER SYSTEMS

PART 1 GENERAL

1.01 SUMMARY OF WORK
A. Pressure test water mains and indoor water pipe in accordance with this Section.

1.02 RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 33 14 11 – Ductile Iron and Polyvinyl Chloride Pipe for Buried Piping.
C. Section 33 14 19 – Valves and Hydrants.
D. Section 40 23 23 – Process Piping and Specialties.

1.03 REFERENCES

1.04 SUBMITTALS (NOT USED)

1.05 MEASUREMENT AND PAYMENT
A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

3.01 PRESSURE TESTING
A. Perform Work in accordance with AWWA C600 and AWWA C605.
B. Test piping at 200 psi or as indicated on plans for 2 hours.
C. Install blind flange on vertical section of piping that enters above Process Piping Room floor. Provide tap in blind flange to allow removal of entrapped air.
D. Ensure all thrust blocks have been properly installed and are sufficiently cured.
E. Fill and flush new piping with potable water, ensuring that all trapped air is removed.
F. Isolate new piping from the existing system.
G. Pressure test new piping in sections by isolating each section using in-line valves. Relieve pressure on non-test side of valve.
H. Pressurize new piping to test pressure at lowest point in the isolated system. Do not pressurize to more than 5 psi over test pressure at lowest point in the isolated system.

I. Monitor pressure in the line being tested for a period of not less than 2 hours.

J. If at any point during that 2-hour period the pressure drops to 5 psi below test pressure, re-pressurize by pumping water into the line in sufficient quantity to bring pressure back to between test pressure and 5 psi above test pressure. Accurately measure the quantity of water required to re-pressurize the pipe.

K. At the end of the 2-hour period, if pressure in the line has dropped below test pressure, re-pressurize to test pressure. Accurately measure the quantity of water required to re-pressurize the pipe.

L. Allowable leakage, in gallons, per hour of testing shall equal \((LD(P)^{1/2}) / 148,000\).
   \[
   L = \text{length of pipe section being tested in feet}
   
   D = \text{nominal diameter of pipe in inches}
   
   P = \text{average test pressure in psig}
   \]

M. Leakage equals total quantity of water required to keep the line pressurized during the 2-hour test period and re-pressurize the line at the end of the test period.

N. If average leakage per hour is less than allowable leakage, the pressure test is acceptable.

O. If average leakage per hour is more than allowable leakage, the pressure test is not acceptable. Locate and make approved repairs as necessary until leakage is within specific allowance.

P. If pressure in the isolated line never drops to test pressure, having started no more than 5 psi above test pressure, the pressure test is acceptable.

Q. Repair visible leaks regardless of the quantity of leakage.

** END OF SECTION **
PART 1  GENERAL

1.01  SUMMARY OF WORK

A. This Section includes water mains, waste line, fittings, and appurtenances as shown on the Plans, complete with accessories.

1.02  RELATED SECTIONS

A. Section 31 23 33 – Trenching and Backfilling.
B. Section 33 01 10.58 – Disinfection of Water Distribution Systems.
C. Section 33 01 12.10 – Pressure Testing Water Mains.
D. Section 33 14 19 – Valves and Hydrants.

1.03  REFERENCES


Q. Iowa Statewide Urban Design and Specifications (SUDAS).

1.04 SUBMITTALS

A. Submit the following items for materials provided by the Contractor:
   1. Manufacturer’s certification that materials furnished are in compliance with applicable requirements of referenced standards and this Section.
   2. Drawings and manufacturer’s data showing details of pipe and fittings to comply with this Section.
   3. Class of pipe and fittings.
   4. Restrained joint details for Engineer’s approval.

B. Provide dimensional drawings, fabrication details, functional description, and properly identified catalog data on pipe and equipment to prove complete compliance with Drawings and Specifications.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 GENERAL

A. Use pipe material identified on Contract Drawings.

2.02 DUCTILE IRON PIPE

A. Special Thickness Class 53 per AWWA C150.

B. Manufacture pipe in accordance with AWWA C151.

C. Provide asphaltic outside coating per AWWA C151, 1 mil in thickness.

D. Cement Mortar Lining:
   1. Provide pipe with standard thickness cement mortar lining per AWWA C104.
   2. Seal-coat cement mortar lining in accordance with AWWA C104.

2.03 POLYVINYL CHLORIDE PIPE C-900

A. Use Class 235 (DR 18) pipe with ductile iron pipe-equivalent outside diameters.

B. Manufacture pipe in accordance with AWWA C900.

C. Use restrained-joint PVC pipe for pipe installed using horizontal directional drilling or as shown on Drawings.

D. Use blue pipe.
2.04 FITTINGS FOR DUCTILE IRON AND POLYVINYL CHLORIDE PIPE

A. Compact fittings in accordance with AWWA C153, or full size in accordance with AWWA C110.

B. Use ductile iron material for construction in accordance with AWWA C110.

C. Joints:
   1. Mechanical in accordance with AWWA C111 and restrained.
      a. T-bolts and hex-head nuts for mechanical joints in accordance with AWWA C111.
         (1) Material: low carbon alloy weathering Cor-Ten steel.
         (2) Coating: Cor-Blue fluorocarbon resin.
         (3) Color: Blue.
         (4) Approved Manufacturers:
            (a) Birmingham Fastener Manufacturing Fluorocarbon Coated T-Head Bolt.
            (b) Or approved equal.
   2. Flanged in accordance with AWWA C115, as indicated on the Plans, with ANSI Class 125 full-faced flange.
      b. Nuts and bolts: stainless steel in accordance with ASTM A320, Type 304.

D. Pressure Rating:
<table>
<thead>
<tr>
<th>Size (inches)</th>
<th>Pressure Rating (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 - 24</td>
<td>350</td>
</tr>
<tr>
<td>30 – 48</td>
<td>250</td>
</tr>
</tbody>
</table>

E. Provide asphaltic outside coating per AWWA C110, 1 mil in thickness.

F. Cement Mortar Lining:
   1. Provide standard thickness cement mortar lining per AWWA C104.
   2. Seal-coat cement mortar lining in accordance with AWWA C104.

2.05 JOINTS FOR DUCTILE IRON AND POLYVINYL CHLORIDE PIPE

A. Use push-on joints using an integral bell with an elastomeric or nitrile gasket in accordance with AWWA C111, mechanical in accordance with AWWA C111, or restrained as needed for thrust restraint.

B. Use ductile iron for follower glands for mechanical joints.

C. Solvent cement joints are strictly prohibited.

D. T-bolts and hex-head nuts for mechanical joints in accordance with AWWA C111.
   2. Coating: Cor-Blue fluorocarbon resin.
   4. Approved Manufacturers:
      a. Birmingham Fastener Manufacturing Fluorocarbon Coated T-Head Bolt.
      b. Or approved equal.

2.06 RESTRAINED JOINTS

A. Mechanical Joint:
   1. Incorporate restraint for all mechanical joints into the design of the follower gland.
   2. Retainer gland design shall impart multiple wedging actions against the pipe, increasing its resistance as pressure increases.
   3. Restrained joints to consist of a mechanical joint with retainer gland or manufacturer’s proprietary-restrained joint.
4. Conform dimensions to the requirements of AWWA C111 and AWWA C153.
5. Pressure rating:
   b. Minimum of 350 psi for ductile iron pipe for sizes 16 inches and smaller.
   c. Minimum of 250 psi for ductile iron pipe for sizes 18 inches and larger.
6. Color:
   a. Red for PVC pipe.
   b. Black for ductile iron pipe.
7. Materials for construction:
   a. Body, wedge segments, and break-off bolt assemblies: Grade 65-45-12 ductile iron as specified by ASTM A536.
   b. Coating to be electrostatically applied and heat cured.
      (1) Approved manufacturers:
         (a) MEGA-BOND by EBAA Iron, Inc.
         (b) CORRSAFE by Sigma.
         (c) Starbond by Star Products.
         (d) Resicoat R2-ES by Tyler Union.
         (e) Or approved equal.
9. Use ductile iron retainer wedge segments heat-treated to a minimum Brinell hardness number of 370.
10. Incorporate twist-off nuts, the same size as hex-head nuts for T-bolts, into the design to ensure proper actuating torque is applied during installation.
11. Approved manufacturers for PVC pipe:
    a. Megalug by EBAA Iron Inc. Series 2000PV.
    b. One-Lok by Sigma Series SLCE.
    c. Stargrip by Star Products Series 4000.
    d. TUFGrip by Tyler Union Series 2000.
    e. Or approved equal.
12. Approved manufacturers for ductile iron pipe:
    b. One-Lok by Sigma Series SLDE.
    c. Stargrip by Star Products Series 3000.
    d. TUFGrip by Tyler Union Series 1000.
    e. Or approved equal.

B. PVC Pipe Joint:
1. Provide restraint for in-line PVC pipe through the use of groove and spline or grip ring located in the bell that provides full-circumferential restrained joint.
2. Restraint joints to have a minimum pressure rating of 150 psi.
3. Manufacturers:
   a. Certa-Lok by Certainteed.
   b. Diamond Lok-21 by Diamond Plastics.
   c. Eagle Loc 900 by JM Eagle.
   d. Or approved equal.

C. Ductile Iron Pipe Joint:
1. Restraint for in-line ductile iron pipe shall consist of the manufacturer's proprietary-restrained joint.
2. Restraint joints to have a minimum pressure rating of 250 psi.

2.07 POLYETHYLENE PIPE ENCASEMENT MATERIAL (DUCTILE IRON PIPE AND FITTINGS)
A. Use polyethylene encasement manufactured in accordance with AWWA C105.
B. Linear low-density polyethylene film.
C. Minimum thickness to be 8 mils.
D. Color: Blue.

E. Physical Properties:
   1. Tensile strength 3600 psi, minimum.
   2. Elongation 800 percent, minimum.
   3. Dielectric strength 800 V/mil, minimum.
   4. Impact resistance 600 g, minimum.
   5. Propagation tear resistance 2550 gf, minimum.

F. Use flat-width tubing of the following sizes:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Tubing Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inches</td>
<td>14 inches</td>
</tr>
<tr>
<td>4 inches</td>
<td>14 inches</td>
</tr>
<tr>
<td>6 inches</td>
<td>16 inches</td>
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<tr>
<td>8 inches</td>
<td>20 inches</td>
</tr>
<tr>
<td>12 inches</td>
<td>27 inches</td>
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<tr>
<td>16 inches</td>
<td>34 inches</td>
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<tr>
<td>20 inches</td>
<td>41 inches</td>
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<tr>
<td>24 inches</td>
<td>54 inches</td>
</tr>
<tr>
<td>30 inches</td>
<td>67 inches</td>
</tr>
<tr>
<td>36 inches</td>
<td>81 inches</td>
</tr>
</tbody>
</table>

G. Markings shall contain the following information spaced every 2 feet apart:
   1. Name of manufacturer.
   2. Year of manufacture.
   3. ANSI/AWWA C105-A21.5.
   4. 8 mil linear low-density polyethylene (LLDPE).
   5. Applicable range of nominal pipe diameter.

H. Sheet material can be used to wrap irregular-shaped valves and fittings.

I. Use 2-inch-wide, 10-mil-thick pressure-sensitive polyethylene tape to close seams and hold overlaps.

2.08 TRACER SYSTEM

A. Tracer Wire:
   1. Open Cut:
      a. No. 14 AWG high-strength copper clad steel (HS-CCS) manufactured by Copperhead Industries, or pre-approved equal.
         (1) Insulation: 30 mil, high-density, high molecular weight polyethylene (HDPE) and rated for direct burial at 30 volts.
         (2) HW-CCS Conductor: 21 percent conductivity for locating purposes with a minimum 282 pounds break load.
         (3) Origin of copper clad steel manufacture is required, and steel core must be manufactured in the United States.
         (4) Color: Blue.
2. Directional Drilling/Boring:
   a. No. 12 AWG extra-high-strength copper clad steel conductor (EHS-CCS) manufactured by Copperhead Industries for directional drilling and boring applications, or pre-approved equal.
      (1) Insulation: 45 mil, high-density, high molecular weight polyethylene (HDPE) and rated for direct burial at 30 volts.
      (2) EHS-CCS Conductor: 21 percent conductivity for locating purposes with a minimum 1150 pounds break load.
      (3) Origin of copper clad steel manufacture is required, and steel core must be manufactured in the United States.
      (4) Color: Blue.
   b. Install tracer wire on pipe installations with a combination of open cut and directional drilling to meet directional drilling requirements.

B. Anode Ground Rod:
   1. 1-pound magnesium drive-in anode, 1.315-inch diameter by 18.5-inch length, manufactured by Copperhead Industries, or pre-approved equal.
   2. Cap installed on one end of anode ground rod to be HDPE.
   3. Provide a beveled pointed end on anode ground rod opposite of cap to aid in hammering into ground.
   4. Wire from cap for anode ground rod to tracer wire connection:
      a. No. 14 AWG copper clad steel (HS-CCS) manufactured by Copperhead Industries, or approved equal.
      b. Insulation: 30 mil, high-density, high molecular weight polyethylene (HDPE) and rated for direct burial at 30 volts.
      c. Length: 10 feet.
         (1) HS-CCS Conductor: 21 percent conductivity for locating purposes with a minimum 250 pounds break load.
      d. Color: Red.

C. Wire Splice Connector:
   1. Tracer wire splices shall only be used to connect the anode ground rod to the tracer wire.
   2. Tracer wire splices will not be allowed between anode ground rods and connection terminal.
   3. Splices used for tracer wire repair must be approved by Engineer.
      b. Or approved equal.

D. Tracer Wire Connection:
   1. Rhino TriView TracerPed or approved equal.
      a. Three internal terminals with two shunts.
      b. 5-foot white plastic triangular post.
      c. Removable top cap with lock.
      d. Three 2-7/8-inch by 14-inch custom vinyl decals No. SD-5594K.
      e. Tri-grip anchor.

PART 3  EXECUTION

3.01 HANDLING, STORAGE, AND SHIPPING

A. Handle pipe carefully.

B. Use blocking and hold-downs during shipment to prevent movement or shifting.

C. Pipe with damage to cement mortar lining will be rejected with field-patching not permitted.

D. Do not telescope small pipe inside larger pipe for shipment and storage.
E. Handle pipe materials by use of nylon straps, wide canvas or padded slings, wide-padded forks and skids, or other approved means designed to prevent damage to the polyethylene encasement. Unpadded chains, sharp edges or buckets, wire ropes, narrow forks, hooks, and metal bars are unacceptable.

F. Dropping or rolling of pipe material is not permitted.

G. Do not store PVC pipe in direct sunlight for prolonged periods of time.

H. Protect pipe to prevent dirt entering pipe.

3.02 GENERAL PIPE INSTALLATION

A. Protect pipe joints from injury while handling and storing.

B. Use no deformed, defective, gouged, or otherwise impaired pipe.

C. Excavate and prepare trench as specified in Section 31 23 33.

D. Install ductile iron pipe in accordance with AWWA C600.

E. Install PVC pipe in accordance with AWWA C605.

F. Prepare trench bottom with sufficient exactness before pipe is installed so that only minor movement of the pipe will be necessary after installation.

G. Clean pipe interior prior to placement in trench.

H. Install pipe to line and grade shown on Plans with an allowable tolerance of plus or minus inches.

I. Maintain uniform bearing along full length of pipe barrel at all times.
   1. Blocking the pipe up will not be acceptable.
   2. Excavate trench bottoms deeper at the location of bell joints to permit body of pipe to rest uniformly supported upon trench bottom.
   3. Limit length of bell holes to no longer than necessary for practical installation of pipe.

J. Clean joint surfaces of dirt and foreign matter using a wire brush before jointing pipe.

K. Lubricate gasket and pipe bell. Provide good grade lubricant meeting manufacturer's recommendations. Use a lubricant approved for use with potable water.

L. Make joints in strict accordance with manufacturer's recommendations.

M. Deflect joints within manufacturer's specifications for maximum deflections.

N. Evenly tighten bolts on mechanical joints around pipe by alternating from one side of pipe to the other.

O. Cut pipe in a neat manner, without damage to pipe or cement mortar lining, if any. Leave a smooth end at right angles to the axis of the pipe. Bevel-cut pipe ends for push-on-type joints in accordance with manufacturer's recommendations.

P. Do not install pipe in water, nor allow water to rise in trench around the pipe.

Q. Place watertight bulkheads on exposed ends of the pipe at all times when pipe installation is not actually in progress.

R. Backfill and compact around pipe as outlined in Section 31 23 33.
3.03 INSTALLATION OF POLYETHYLENE PIPE ENCASEMENT MATERIAL

A. Use polyethylene encasement material on buried ductile iron pipe, fittings, rods, and appurtenances in accordance with AWWA C105, Method A.

B. Use polyethylene tubing to encase pipe.

C. Cut tubing 2 feet longer than pipe section. Overlap tubing 1 foot at each end of pipe.

D. Gather and lap tubing to provide a snug fit.

E. Secure lap at quarter points with polyethylene tape. Secure each end of tube with a complete wrap of polyethylene tape.

F. Use polyethylene encasement to prevent contact between pipe and bedding material. The polyethylene encasement is not intended to be a completely airtight and watertight enclosure.

G. Repair damaged polyethylene encasement material using polyethylene tape or replace damaged section(s).

H. Pick and move polyethylene-encased pipe with nylon slings; wire rope is not permitted.

3.04 THRUST BLOCKS

A. Provide concrete thrust blocks or collars at all changes in alignment, tees, and dead ends.

B. Use concrete thrust blocks to supplement use of restrained joints as thrust restraint on buried piping.

C. Carry thrust blocks or collars to undisturbed soil that will provide adequate bearing.

D. The bearing area of thrust blocks or collars, in square feet, as shown on the plans. Minimum thickness for any thrust block to be 1.5 times outside pipe diameter or 18 inches, whichever is greater.

E. Hold thrust blocks or collars back 3 inches from all bolts, nuts, glands, or other jointing materials. Ensure joints could be remade without disturbing thrust block or collar.

F. Provide bond breaker between thrust block or collar and pipe. Polyethylene encasement material will be considered an acceptable bond breaker.

G. Provide thrust blocks at all connections to existing water mains.

3.05 TRACER SYSTEM INSTALLATION

A. Install tracer wire with buried piping.

B. Duct tape tracer wire to pipe every 5 feet in the 5 or 7 o’clock position to prevent damage to the wire during backfill and future construction exposure.

C. Install anode ground rods adjacent to connections to existing piping and at each fire hydrant.

D. Terminate tracer wire in tracer wire connection next to each fire hydrant or other locations directed by Engineer.

E. Wire splice connectors can only be used to connect ground rods to tracer wire. Wire splice connectors are not allowed at any other locations unless approved by Engineer. Provide long enough roll of tracer wire to not need the use of wire splice connectors.
F. Allow Engineer to inspect underground splices prior to backfilling.

G. Tracer wire installation is considered incidental to water main installation.

3.06 SEPARATION DISTANCE

A. Horizontal separation of water mains from gravity sewers:
   1. Provide a horizontal separation distance of at least 10 feet between water mains and gravity sewer mains, unless both of the following conditions can be met:
      a. Bottom of water main is at least 18 inches above top of sewer.
      b. Water main is placed in a separate trench with a minimum 3-foot horizontal separation.
   2. When it is impossible to obtain the required 3-foot horizontal clearance and 18-inch vertical separation, the sewer must be replaced with water main quality materials having a minimum pressure rating of 150 psi and meeting requirements of Section 33 14 11. In no case shall linear separation be less than 2 feet.

B. Horizontal separation of water mains from sewer force mains:
   1. Provide a horizontal separation distance of at least 10 feet between water mains and sewer force mains, unless both of the following conditions can be met:
      a. Force main is constructed of water main quality materials having a minimum pressure rating of 150 psi and meeting requirements of Section 33 14 11.
      b. Water main is laid at least 4 linear feet from sewer force main.

C. Vertical separation of water mains from sanitary sewer crossovers:
   1. Provide a vertical separation of at least 18 inches from bottom of water main to top of sanitary sewer whenever possible where water mains cross over sanitary sewers. If 18 inches cannot be met, provide a minimum vertical separation of 6 inches and place water main inside 20 feet of a larger diameter polyvinyl chloride water main casing pipe with no casing chocks centered on the sanitary sewer.
   2. Provide a vertical separation of at least 18 inches from bottom of sanitary sewer to top of water main in cases where water mains cross under the sanitary sewer. Place water main inside 20 feet of a larger diameter polyvinyl chloride water main casing pipe with no casing chocks centered on the sanitary sewer.
   3. Adequately support both water and sanitary sewer pipes and provide watertight joints.

D. Vertical separation of water mains from storm sewer crossovers:
   1. Provide a vertical separation of at least 18 inches from bottom of water main to top of storm sewer whenever possible where water mains cross over storm sewers. If 18 inches cannot be met, provide a minimum vertical separation of 6 inches and construct with one of the following methods:
      a. Verify storm sewer has gasketed joints.
      b. Install water main of 20 feet of ductile iron pipe material with nitrile gaskets.
      c. Encase storm sewer.
      d. Encase water main.
   2. Provide a minimum vertical separation of at least 18 inches from bottom of storm sewer to top of water main in cases where water mains cross under storm sewer mains and construct with one of the following methods:
      a. Verify storm sewer has gasketed joints.
      b. Install water main of 20 feet of ductile iron pipe material with nitrile gaskets.
      c. Encase storm sewer.
      d. Encase water main.
   3. Adequately support both water and storm sewer pipes and provide watertight joints.
E. Separation of water mains from sewer manholes:
   1. No water pipe shall pass through or come in contact with any part of a sewer manhole.
   2. Provide a horizontal separation distance of at least 10 feet between water mains and sewer manholes.

F. Advise Engineer should physical conditions exist such that exceptions to Part 3.02 of this Section are necessary.

3.07 TESTING AND CHLORINATION

A. Perform hydrostatic and leakage tests on buried water main piping in accordance with Section 33 01 12.10.

B. Disinfect all water mains in accordance with Section 33 01 10.58.

C. A tracer wire test will be conducted by Owner prior to acceptance of the Project. The tracer wire system including terminations at all TriViews, anode ground rods, and splice kits are to be completely installed prior to tracer wire test. Discontinuities found in tracer system to be corrected by Contractor at Contractor’s expense.

** END OF SECTION **
SECTION 33 14 19
VALVES AND HYDRANTS

PART 1 GENERAL

1.01 SUMMARY OF WORK
A. This Section includes valves and hydrants as shown on the Plans, complete with accessories.

1.02 RELATED SECTIONS
A. Section 31 23 33 – Excavating, Backfilling, and Compacting for Water Mains.
B. Section 33 01 10.58 – Disinfection of Water Systems.
C. Section 33 01 12.10 – Pressure Testing Water Systems.
D. Section 33 14 11 – Ductile Iron and Polyvinyl Chloride Pipe for Buried Piping.

1.03 REFERENCES

N. Steel Structures Painting Council, Surface Preparation Specification No. 6 (SSPC-SP6) – Commercial Blast Cleaning.

1.04 SUBMITTALS

A. Submit manufacturer’s certification that materials furnished are in compliance with applicable requirements of referenced standards and this Section.

B. Provide dimensional drawings, fabrication details, functional description, and properly identified catalog data on all items to prove complete compliance with Drawings and Specifications.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 GATE VALVES (EXCLUDING SE POLK)

A. Provide resilient-seated gate valves manufactured in accordance with AWWA C509 or AWWA C515.
   1. Type of service: buried service handling potable water with a pH range of 9.5 to 9.8.
   3. Provide valves with non-rising stem.
   4. Provide 2-inch by 2-inch wrench operating nut that opens valves when turned in clockwise direction (open to the right), unless noted otherwise on Drawings.
   5. Valve gearing for 20-inch to 48-inch valves:
      a. Provide valve with gear box.
      b. Provide vertical valve unless otherwise specified on Drawings.
      c. Use the following gear ratios for the corresponding sizes:

<table>
<thead>
<tr>
<th>Valve Size (inches)</th>
<th>Gear Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>3 to 1</td>
</tr>
<tr>
<td>24</td>
<td>3 to 1</td>
</tr>
<tr>
<td>30</td>
<td>6 to 1</td>
</tr>
<tr>
<td>36</td>
<td>6 to 1</td>
</tr>
<tr>
<td>42</td>
<td>8 to 1</td>
</tr>
<tr>
<td>48</td>
<td>8 to 1</td>
</tr>
</tbody>
</table>

d. Totally enclosed type, oil-filled, and designed for buried and submerged service.

e. Materials of construction:
   (1) Gear housing: ductile iron.
   (2) Gears: carbon steel.
   (3) Pinion shaft: 304 stainless steel.
   (4) Design input shaft with a ball bearing and sealed with O-rings.
   (5) Exposed hex nuts and bolts: 304 stainless steel.

B. Materials of Construction:
   2. Gate: cast or ductile iron fully encapsulated with synthetic rubber.
   4. O-rings: Buna-N.
5. Exposed hex bolts and nuts: 304 stainless steel.

6. Joints:
   a. Mechanical in accordance with AWWA C111.
      (1) Gaskets: Buna-N or nitrile.
      (2) Nuts and bolts:
         (a) All T-bolts and hex-head nuts for mechanical joints in accordance with AWWA C111.
         (b) Material: low carbon alloy weathering Cor-Ten steel.
         (c) Coating: Cor-Blue fluorocarbon resin.
         (d) Color: Blue.
         (e) Approved Manufacturers:
            1) Birmingham Fastener Manufacturing Fluorocarbon Coated T-Head Bolt.
            2) Or approved equal.
   b. Flanged in accordance with AWWA C115, as indicated on the Plans, with ANSI Class 125 full-faced flange.
      (1) Gaskets: Buna-N or nitrile, of thickness compatible with machining tolerances of flange faces. Minimum thickness: 1/8-inch.
      (2) Nuts and bolts: 304 stainless steel.

C. Design valve to:
   1. Allow replacement of upper O-ring while valve is under pressure in full-open position.
   2. Not permit metal-to-metal contact between gate and body.
   3. Accommodate full-size tapping machine shell cutter.

D. Horizontal valves are required to have a cleaning system on both sides of the gate consisting of materials that are non-corrosive.

E. Interior and exterior valve coating minimum of 10-mil-thick fusion-bonded epoxy per AWWA C550.

F. Operating valve through 500 cycles at rated pressure must not result in disbondment or degradation of coating. Certification will be required for manufacturers not listed below.

G. Indicate manufacturer, casting year, size, working pressure, and body material (ductile iron) in valve casting.

H. Manufacturers’ Models for 4-inch to 16-inch valves:
   1. Clow Model 2638.
   4. M & H Style 4067.
   5. EJ Flowmaster.
   6. Approved equal.

I. Manufacturers’ Models for 20-inch to 48-inch valves:
   1. Clow Model 2638.
   4. EJ Flowmaster.
   5. Approved equal.

2.02 HYDRANTS (POLK COUNTY) (EXCLUDING SE POLK)

A. Hydrants manufactured in accordance with AWWA C502.

B. Use dry-barrel, breakaway-type hydrants designed to break near ground line on impact. The breaking ring consists of a full circumference one-piece or split-contact retaining ring.

C. Provide flanged connections for head and base to hydrant barrel.

D. Provide 6-inch mechanical joint shoe with harnessing lugs.
E. Provide 4-1/2-inch-minimum-diameter main valve with bronze seat ring. Thread seat ring directly to bronze bushing or drain ring that is securely locked to hydrant shoe.

F. Provide pentagon-shaped operating nut with weather cap. Dimension from point to flat at top of operating nut: 1-3/16-inch.

G. Provide two 2-1/2-inch hose nozzles and one 4-inch pumper nozzle with caps having nut with dimensions identical to operating nut:
   1. Hose nozzle threads
      a. Outside diameter of male thread: 3-1/16 inches
      b. Diameter at root of male thread: 2-7/8 inches
      c. Threads per inch: 7-1/2
      d. Length of nozzle threads: 1 inch
      e. Cut off at top of threads: 1/4 inch
   2. Pumper nozzle threads
      a. Outside diameter of male thread: 4-31/32 inches
      b. Diameter at root of male thread: 4-19/32 inches
      c. Threads per inch: 4
      d. Length of nozzle threads: 1-1/2 inches
      e. Cut off at top of threads: 1/4 inch

H. Provide markings cast-in-bonnet that indicate direction of opening. Hydrants to open clockwise (to the right).

I. Provide anti-thrust washers for ease of operation.

J. Provide grease chamber or oil reservoir, sealed by means of O-rings, for lubrication of operation threads. Provide lubricant suitable for contact with potable water.

K. Painting:
   1. Prepare surfaces to be coated according to SSPC-SP6, commercial blast cleaning.
   2. Coat hydrant in accordance with AWWA C502 and coating manufacturer's instructions.
   3. Tnemec epoxy paint system (Alternative 1)
      a. Coat interior surfaces, other than machined surfaces, with asphaltic coating.
      b. Coat exterior surfaces below grade with two coats of asphaltic coating.
      c. Prime exterior surfaces above grade using an aromatic urethane, zinc-rich system with 2.5 to 3.5 mils dry film thickness. Tnemec Series 90-97.
      d. Paint exterior surfaces above grade using an aliphatic acrylic polyurethane system at 2.5 to 3.5 mils dry film thickness. Tnemec Series 73.
      e. Apply a 2 to 3 mils dry film thickness of high gloss clear coat to exterior surfaces above grade after paint has been allowed to dry thoroughly. Tnemec Series 1079.
      f. Color:
         (1) Asphaltic coating: Black.
         (2) Primer: Reddish-gray.
         (3) Body: Bright Yellow (03SF).
         (4) Bonnet: Safety Green (09SF).
         (5) Caps: Bright Yellow (03SF).
   4. Tnemec epoxy paint system (Alternative 2)
      a. Coat interior surfaces, other than machined surfaces, with asphaltic coating.
      b. Coat exterior surfaces below grade with two coats of asphaltic coating.
      c. Prime exterior surfaces above grade using a polyamide epoxy system, Tnemec Series 20, FC20 or 66, and paint using an aliphatic acrylic polyurethane system, Tnemec Series 75, or approved equal. Provide total dry mil thickness of 5 to 7 mils.
      d. Apply a 2 to 4 mils dry thickness of clear coat to exterior surfaces above grade after paint has been allowed to dry thoroughly.
      e. Color:
         (1) Asphaltic coating: Black.
         (2) Primer: White (AA83).
         (3) Paint: Bright Yellow (SC02).
5. Approved equal.
   a. System must be approved by DMWW prior to bid opening.

L. Materials of Construction:
   1. Breakaway stem coupling: steel, cast iron, or stainless steel.
   2. Bonnet barrel, shoe, gate, and nozzle caps: cast iron.
   3. Threaded internal components exposed to water, valve seats, and nozzles: bronze.
   4. Cotter pins, drive pins, bolts, and screws exposed to water: stainless steel or brass.
   5. Exterior bolts, nuts, set screws, and other miscellaneous fasteners: stainless steel or bronze.
      Metal components in contact with water shall comply with requirements of ASTM B584 copper alloy UNS No. C89520 or UNS No. C89833. Residual lead levels of the metal not to exceed 0.25 percent by weight as cast or extruded.

M. Manufacturers:
   1. Clow Medallion.
   2. Mueller Centurion.
   3. Approved equal.

2.03 JOINTS FOR VALVES AND HYDRANTS

A. Use mechanical joints in accordance with AWWA C111, or restrained as indicated on Plans.

B. Use ductile-iron follower glands for mechanical joints.

C. Bolts:
   1. All T-bolts and hex-head nuts for mechanical joints in accordance with AWWA C111.
      b. Coating: Cor-Blue fluorocarbon resin.
      c. Color: Blue.
      d. Approved Manufacturers:
         (1) Birmingham Fastener Manufacturing Fluorocarbon Coated T-Head Bolt.
         (2) Or approved equal.
   2. All bolts and hex nuts for flanged joints of 304 stainless steel.

D. Use flange joints having 1/8-inch rubber ring gaskets for nominal diameters of 24 inches or less and 1/8-inch rubber ring gaskets for nominal diameter greater than 24 inches.

E. Use elastomeric or nitrile gaskets in accordance with AWWA C111.

2.04 RETAINER GLANDS

A. Incorporate restraint for all mechanical joints into design of follower gland.

B. Use a retainer gland design imparting multiple wedging actions against the pipe, increasing its resistance as pressure increases.

C. Restrained joints to consist of a mechanical joint with retainer gland or manufacturer's proprietary-restrained joint.

D. Dimensions conforming to the requirements of AWWA C111 and AWWA C153.

E. Pressure rating:
   3. Minimum of 250 psi for ductile iron pipe for sizes 18-inch and larger.
F. Color:
   1. Red for PVC pipe.
   2. Black for ductile iron pipe.

G. Materials for construction:
   1. Body, wedge segments, and break-off bolt assemblies: Grade 65-45-12 ductile iron as specified by ASTM A536.
   2. Coating to be electrostatically applied and heat cured.
      a. Approved manufacturers:
         (1) MEGA-BOND by EBAA Iron, Inc.
         (2) CORRSAFE by Sigma.
         (3) Starbond by Star Products.
         (4) Resicoat R2-ES by Tyler Union.
         (5) EZ Shield by SIP Industries.
         (6) Or approved equal.

H. Minimum factor of safety of 2.

I. Use ductile iron retainer wedge segments heat-treated to a minimum Brinell hardness number of 370.

J. Incorporate twist-off nuts, the same size as hex-head nuts for T-bolts, into the design to ensure proper actuating torque is applied during installation.

K. Approved manufacturers for PVC pipe:
   1. Megalug by EBAA Iron Inc. Series 2000PV.
   2. One-Lok by Sigma Series SLCE.
   4. TUFGrip by Tyler Union Series 2000.
   5. EZ Grip by SIP Industries Series EZP.
   6. Or approved equal.

L. Approved manufacturers for ductile-iron pipe:
   2. One-Lok by Sigma Series SLDE.
   4. TUFGrip by Tyler Union Series 1000.
   5. EZ Grip by SIP Industries Series EZD.
   6. Or approved equal.

2.05 VALVE BOXES

A. Provide cast iron screw-type adjustable heavy-duty valve box with cast iron stay-put cover marked "WATER" for each buried valve.

B. Minimum inside diameter of valve boxes of 5-1/8 inches.

C. Weight of valve box assembled, top and bottom sections, without valve box lid as follows:

<table>
<thead>
<tr>
<th>Extension Height (inches)</th>
<th>Weight (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>27-37</td>
<td>71</td>
</tr>
<tr>
<td>33-43</td>
<td>78</td>
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<td>36-52</td>
<td>93</td>
</tr>
<tr>
<td>39-60</td>
<td>100</td>
</tr>
</tbody>
</table>

D. Tyler No. 6850 29-U Domestic, or approved equal.
E. For an approved equal, provide proof that all parts of proposed valve box can be interchangeable with Tyler No. 6850 29-U Domestic.

F. Install valve boxes upon valve with the use of a rubber Valve Box Adapter II as manufactured by Adaptor Inc., or approved equal.

2.06 POLYETHYLENE ENCASEMENT MATERIAL

A. Polyethylene encasement manufactured in accordance with AWWA C105.

B. Linear low-density polyethylene film.

C. Minimum thickness of 8 mils.

D. Color: Blue.

E. Physical Properties:
   1. Tensile strength 3600 psi, minimum.
   2. Elongation 800 percent, minimum.
   3. Dielectric strength 800 V/mil, minimum.
   4. Impact resistance 600 g, minimum.
   5. Propagation tear resistance 2550 gf, minimum.

F. Sheet material can be used to wrap irregular-shaped valves and fittings.

G. Use 2-inch-wide, 10-mil-thick pressure-sensitive polyethylene tape to close seams and hold overlaps.

PART 3 EXECUTION

3.01 HANDLING, STORAGE, AND SHIPPING

A. Handle valves and hydrants carefully.

B. Use blocking and hold-downs during shipment to prevent movement or shifting.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Protect valves and hydrants from injury while handling and storing.

B. Use no defective, damaged, or otherwise impaired materials.

C. Prepare excavation as outlined in Section 31 23 33.

D. Install valves and hydrants in accordance with AWWA C600.

E. Clean interior of valve or hydrant prior to placement in trench.

F. Install valves and hydrants to line and grade as shown on plans.

G. Install valves and hydrants plumb.

H. Clean joint surfaces of dirt and foreign matter using a wire brush before jointing.

I. Lubricate gasket and bell. Provide food grade lubricant meeting manufacturer's recommendations. Use lubricant approved for use with potable water.

J. Make joints in strict accordance with manufacturer's recommendations.
K. Evenly tighten bolts on mechanical joints or flanged joints around pipe by alternating from one side of the pipe to the other. Follow manufacturer's installation specifications for electrical isolation flanges to prevent damage during bolt torquing.

L. Backfill and compact around hydrants and valves as outlined in Section 31 23 33.

3.03 VALVE INSTALLATION

A. Do not support valves off of piping.

B. Ensure that valve box is centered over operating nut.

C. Install Rubber Valve Box Adapter II as manufactured by Adapter Inc., or approved equal, inside of valve box centered on valve.

3.04 HYDRANT INSTALLATION

A. Anchor auxiliary valve to hydrant tee.

B. Install hydrant with break flange more than 1 inch and less than 7 inches above finished grade.

C. The use of hydrant extensions will not be allowed to set hydrant to appropriate height, unless approved by Engineer. Hydrant extensions, if approved, must be from same manufacturer as the fire hydrant.

D. Use restrained joints in hydrant branch.

E. Set hydrant on a solid concrete cinder block not smaller than 8-inch by 16-inch by 4-inch.

F. Provide poured concrete thrust blocks behind hydrant and hydrant tee.

G. Ensure hydrant drain is free-flowing and unobstructed in areas where normal groundwater level is below drain opening.

H. Provide not less than one (1) cubic yard of open-graded granular fill around base of hydrant for drainage.

I. Lubricate and exercise each of the three (3) hydrant caps to prevent seizing. Provide food grade grease lubricant meeting manufacturer’s recommendations. Use lubricant approved for use with potable water.

3.05 INSTALLATION OF POLYETHYLENE PIPE ENCASEMENT MATERIAL

A. Use polyethylene encasement material on buried valves and buried portion of hydrants in accordance with AWWA C105.

B. Wrap valves using polyethylene sheet material to prevent contact with bedding. Secure sheet to adjacent pipe and just below valve operation nut using polyethylene tape.

C. Wrap buried portions of hydrants using 24-inch flat-width polyethylene tubing. Secure tubing to hydrant barrel just below grade using polyethylene tape.

D. The polyethylene encasement preventing contact with bedding material is not intended to be an airtight and watertight enclosure.

E. Repair damaged polyethylene encasement material using polyethylene tape or replace damaged section.
3.06 THRUST BLOCKS

A. Provide concrete thrust blocks at hydrants and hydrant tees.

B. Carry thrust blocks to undisturbed soil that will provide adequate bearing.

C. The bearing area of thrust blocks, in square feet, as shown on the Plans. Minimum thickness for thrust block of 1.5 times outside pipe diameter or 18 inches, whichever is greater.

D. Hold thrust blocks back 3 inches from bolts, nuts, glands, or other jointing materials. Ensure joints could be remade without disturbing thrust block.

E. Provide bond breaker between thrust block and pipe or hydrant. Polyethylene encasement material will be considered an acceptable bond breaker.

3.07 REMOVAL OF ABANDONED FIRE HYDRANTS AND VALVE BOXES

A. Surface restoration items, including pavement removal and replacement, seeding, or sodding, needed to remove abandoned fire hydrants or valve boxes paid in accordance with appropriate bid item in Contract.

B. All other items related to removal of abandoned fire hydrants and valve boxes, including repairs to traffic loops and lawn irrigation systems, incidental to Contract.

C. Remove abandoned fire hydrants by disconnecting pipe from fire hydrant at the shoe.

D. Return abandoned fire hydrants to Des Moines Water Works at 408 Fleur Drive, unless Engineer approves their disposal.

E. Backfill and restore all excavations for fire hydrant removals according to Sections 31 23 33 of these Specifications.

F. Remove abandoned valve box and entire top section, backfill the lower section and excavation, and restore according to Sections 31 23 33 of these Specifications.

** END OF SECTION **
SECTION 40 05 56
PROCESS VALVES AND SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY OF WORK
A. Work under this Section includes furnishing all materials, tools, equipment, labor and supervision to install and test valves inside the booster station building as indicated on the Contract Drawings.

1.02 RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 40 23 23 – Process Piping and Specialties.

1.03 REFERENCES
G. American Water Works Association C515 – Reduced-wall, Resilient-Seated Gate Valves for Water Supply Service.
J. Underwriters Laboratories, Inc. (UL) Specifications and Standards.

1.04 SUBMITTALS
A. Submit manufacturer’s certification that materials furnished are in compliance with applicable requirements of referenced standards and this Specification.
B. Provide dimensional drawings, fabrication details, functional description, and properly identified catalog data on items to document complete compliance with Drawings and Specifications.
C. Submit manufacturer’s published literature and catalog cuts. Submittal should include all required data to prove compliance with Specification.
1.05 MEASUREMENT AND PAYMENT

A. Include cost for all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves shall be sized to match adjacent piping and adapted if necessary, to match pipe ends, material, and pressure rating.

B. Valve to include factory-mounted operator (electric or pneumatic actuator, handwheel, chainwheel, worm and gear operator, wrench nut, extension stem, and chain.), valve, hardware, and support, if needed, for a complete system. See valve schedule for actuator type.

C. Valve shall meet the requirements of NSF 61 for drinking water.

D. Valve description in Valve schedule takes precedence over this Section.

2.02 BALL VALVES

A. Type 1 – Stainless Steel Ball Valves
   1. Use: General-purpose stainless-steel ball valves as shown on Drawings.
   2. Design: Suitable for seating in both directions.
   5. Pressure Rating: Valves rated for 300 psi service.
   6. Provide lockable hand level operator with stops at full open and closed positions.
   7. Acceptable Manufacturers: Watts, Nibco, or approved equal.

B. Type 2 - Standard Polyvinyl Chloride (PVC) Ball Valve
   1. Use: Schedule 80 PVC ball valves of size shown on Drawings.
   2. Style: True union, full port, automatic seat wear adjustment ball valves.
   4. PVC Type 1 according to ASTM D1784 and cell class 12454.
   5. Pressure rating: 235 psi for 1/2-inch to 2-inch and 150 psi for 2-1/2 -inch to 4-inch valves.
   7. Acceptable Manufacturers: Spears, Asahi, Chemtrol or approved equal.

2.03 BUTTERFLY VALVES

A. Type 1 - AWWA Butterfly Valve
   1. Use: Provide butterfly valves as shown on drawings and in valve schedule.
   2. Design: One-piece body design with bi-directional shutoff for full pressure rating of valve. Meets AWWA C504.
   3. Style: AWWA Flanged, Valve Class 150B.
   4. Body Material: Ductile Iron conforming to ASTM A536 A65-45-12 or cast-iron conforming to ASTM A126 Class B.
   5. Disc: Ductile Iron conforming to ASTM A536 Grade 65-45-12 or cast-iron.
   7. Seat: Ethylene propylene diene monomer rubber (EPDM).
   9. Actuator: As indicated on valve schedule.
11. Provide with manufacturers standard coating.
12. Acceptable Manufacturers:
   a. Dezurik AWWA Butterfly Valves (BAW).
   b. Henry Pratt Company.
   c. Or approved equal.

B. Type 2 – Lugged Resilient Seated Butterfly Valve
1. Use: Provide butterfly valves as shown on drawings and in valve schedule.
2. Design: One-piece lug body design with bi-directional shutoff for full pressure rating of valve.
4. Body Material: Ductile Iron conforming to ASTM A536 65-45-12 or cast-iron conforming to ASTM A126 Class B.
6. Shaft: Stainless steel, Type 304 or 416.
7. Seat: Ethylene propylene diene monomer rubber (EPDM).
8. Actuator: as indicated on valve schedule.
10. Provide with manufacturers standard coating.
11. Acceptable Manufacturers:
   b. Henry Pratt Company.
   c. Or approved equal.

2.04 CHECK VALVES

A. Tilting Disc Check Valve: Use a check valve of the tilting disc type that provides short travel from full open to full close and provides the ability to close slowly to avoid contributing to slamming and surges. The valve shall consist of a circular disc, hinged around a fixed pivot above its centerline and offset from the plane of the seat which seals the valve body.
1. Use: On discharge side of pump.
2. Style: Full body type capable of accepting top or bottom mounted dashpot.
3. Body Material: Ductile Iron conforming to ASTM A65-45-12 or cast-iron conforming to ASTM A126 Class B.
4. Disc: Ductile Iron ASTM A536 Grade A65-15-14 or Bronze C90700. Disk to include indicator showing the disc position.
5. Seat rings: Both disc seat and body seat of Stainless Steel. For valves smaller than 10-inches aluminum bronze metal seats are acceptable.
7. Flange connection.
8. Pressure Rating: Rated for 150 psi service.
9. Provide with manufacturer’s standard coating.
10. Valve to include DPDT proximity switch to indicate valve position.
11. Provide Dashpot as indicated on Valve Schedule.
   a. Top Mounted: Provide with factory installed top mounted dashpot to provide independent hydraulic control of valve opening and closing. Dashpot shall be a self-contained oil system, separate and independent from the pipeline. Opening and closing speeds shall be independently adjustable with labeled control valves and cushion chamber.
   b. Bottom Mounted: Provide with factory installed bottom-mounted dashpot to provide control of final portion of valve closure to reduce water hammer normally associated with rapid flow reversal. Dashpot shall be a self-contained oil system, separate and independent from the pipeline. Closing speed shall be adjustable with control valve.
12. Manufacturers:
   a. APCO Slanting Disc Check Valve.
   b. Henry Pratt Company.
   c. Or approved equal.
2.05 PRESSURE/SURGE RELIEF VALVE

A. Pressure relief valves shall be fully automatic hydraulically operated, diaphragm-actuated globe valve. The valve shall be normally closed with a spring-loaded pilot allowed to sense upstream pressure. In the event of high upstream pressure, valve shall open to relieve excess pressure.
   1. Use: To protect system from over pressure by exhausting excess pressure. Valve to operate intermittently to prevent pressure surges which might occur on pump start, stop, or sudden closure of downstream valve.
   2. Style: Pilot controlled globe valve.
   3. Body Material: Ductile Iron conforming to ASTM A65-45-12 or cast-iron conforming to ASTM A126 Class B.
   5. Seat Ring: Stainless Steel.
   7. Pilot tubing and pilot: Stainless Steel.
   8. Diaphragm: Ethylene propylene diene monomer rubber (EPDM).
   9. Provide with Manufacturer’s standard coating.
   11. Manufacturers:
       a. OCV Fluid Solutions.
       b. Cla-Val.
       c. Or approved equal.

2.06 COMBINATION AIR/VACUUM VALVES

A. Combination air valves shall be fully automatic float-operated valves designed to exhaust large quantities of air during filling of a piping system and close upon liquid entry. The valve shall re-open during draining or if a negative pressure occurs. The valve shall also release accumulated air from the piping system while the system is operating under pressure.
   1. Use: At high points in piping and as shown on Drawings.
   3. Body Material: Ductile Iron conforming to ASTM A65-45-12 or cast-iron conforming to ASTM A126 Class B.
   5. Seat Material: Ethylene propylene diene monomer rubber (EPDM).
   6. Provide with full-ported isolation ball valve.
   7. Provide with Manufacturer’s standard coating.
   9. Manufacturers:
       a. APCO Single Body Combination Air Valves.
       b. Henry Pratt Company.
       c. Or approved equal.

2.07 AIR RELEASE VALVE

A. Use clean water air release valves specifically made for use in conjunction with horizontal split-case pumps. Air release valve shall be automatic float-operated valve designed to release accumulated air while the system is operating and under pressure.
   1. Use: Above pumps and as shown on Drawings.
   3. Body Material: Ductile Iron conforming to ASTM A65-45-12 or cast-iron conforming to ASTM A126 Class B.
   5. Orifice Bottom: Viton or Nitrile Rubber (Buna-N).
   6. Provide with full-ported isolation ball valve.
   7. Provide with Manufacturer’s standard coating.
9. Manufacturers:
   a. APCO Clean Water Air Release Model 50.
   b. Henry Pratt Company.
   c. Or approved equal.

2.08 GATE VALVES

A. Provide resilient-seated gate valves manufactured in accordance with AWWA C509 or AWWA C515.
   1. Type of service: Buried service handling potable water with a pH range of 9.0 to 9.8.
   3. Provide valves with non-rising stem.
   4. Provide handwheel operator which opens valves when turned in counterclockwise direction (open to the left), unless noted otherwise on Drawings.

B. Materials of Construction:
   1. Body and bonnet: Ductile iron.
   2. Gate: Cast or ductile iron fully encapsulated with synthetic rubber.
   4. O-rings: Buna-N.
   5. Exposed hex bolts and nuts: 304 stainless steel.
   6. Joints:
      a. Flanged in accordance with AWWA C115, as indicated on the plans, with ANSI Class 125 full-faced flange.
      (1) Gaskets: Buna-N or nitrile, of thickness compatible with machining tolerances of flange faces. Minimum thickness: 1/8-inch.
      (2) Nuts and bolts: 304 stainless steel.

C. Design valve to:
   1. Allow replacement of upper O-ring while valve is under pressure in full-open position.
   2. Not permit metal-to-metal contact between gate and body.
   3. Accommodate full-size tapping machine shell cutter.

D. Horizontal valves are required to have a cleaning system on both sides of the gate consisting of materials that are non-corrosive.

E. Interior and exterior valve coating minimum of 10-mil-thick fusion-bonded epoxy per AWWA C550.

F. Operating valve through 500 cycles at rated pressure must not result in disbondment or degradation of coating. Certification will be required for manufacturers not listed below.

G. Indicate manufacturer, casting year, size, working pressure, and body material (ductile iron) in valve casting.

H. Manufacturers’ Models for 4-inch to 16-inch valves:
   1. Clow Model 2638.
   4. M & H Style 4067.
   5. EJ Flowmaster.
   6. Approved equal.

I. Manufacturers’ Models for 20-inch to 48-inch valves:
   1. Clow Model 2638.
   4. EJ Flowmaster.
   5. Approved equal.
2.09 SOLENOID VALVES

A. General Service Solenoid Valve
   1. Use: Pilot operated general-purpose solenoid valve used to control flow of liquid.
   2. Design: Electromagnetic valves comprised of a coil, core tube, core and enclosure. Supply two-way normally closed valves, unless indicated otherwise on the Drawings.
   6. Core tube: 305 Stainless Steel.
   7. Core and plugnut: 430F Stainless Steel.
   9. Coil: 120 volts, 60 hz.
   11. Lead-free and meets the requirements of NSF 61.
   12. Manufacture: ASCO General Service Solenoid Valves or approved equal.

2.10 VALVE AND EQUIPMENT TAGS

A. Provide multi-layered plastic tags with rotary-engraved or laser-engraved letters.
B. Black lettering on a white tag surface.
C. Outdoor-grade plastic.
D. Provide beaded chain for attachment of tag to valve or equipment.
E. Provide identification tags for all valves as identified by Owner.
F. Manufacturer:
   1. Seton Identification Products.
   2. Brady Corporation.
   3. Iowa Prison Industries.
   4. Or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. See Valve and Equipment Schedule in Contract Drawings for details on each valve.
B. Delivery, Storage, and Handling:
   1. Handle all valves and appurtenances carefully so as not to chip, crack, or have surface coating damaged.
   2. Store valves carefully, so that, in no way shall they be damaged or made unsuitable for installation and use.
   3. Do not skid valves on ground.
   4. Valves to be delivered and stored in original shipping containers with labeling included.
   5. Damaged valves and appurtenances will be rejected.

3.02 VALVE INSTALLATION

A. Install in accordance with manufacturer’s instructions and approved Shop Drawings.
B. Provide clearance for access to valves and fittings.
C. Install valves with stems upright or horizontal, not inverted, unless shown otherwise on Drawings.

D. Use copper or schedule 80 PVC pipe to route discharge of air release valves to nearest floor drain.

3.03 STARTUP

A. Valve installation inspection and startup to be performed by a factory-trained representative who certifies to Engineer that equipment is properly operating and operating personnel have been properly instructed concerning operation and maintenance.

** END OF SECTION **
SECTION 40 23 23
PROCESS PIPING AND SPECIALTIES

PART 1  GENERAL

1.01  SUMMARY OF WORK
A. Work under this Section includes furnishing of all materials, equipment, supervision, and labor necessary to install building process piping.

1.02  RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 09 90 00 – Painting.
C. Section 31 23 33 – Trenching and Backfilling.
D. Section 33 01 10.58 – Disinfection of Water Systems.
E. Section 33 01 12.10 – Pressure Testing Water Systems.
F. Section 33 14 11 – Ductile Iron and Polyvinyl Chloride Pipe for Buried Piping.
G. Section 40 05 56 – Process Valves and Specialties.

1.03  REFERENCES
A. American Iron and Steel Institute (AISI) 316 – Properties of Stainless Steel AISI Type 316.


R. American Welding Society (AWS) A5.8/A5.8M – Specifications for Filler Metals for Brazing and Braze Welding.


T. American Water Works Association (AWWA) C110 – Ductile-Iron and Gray-Iron Fittings, 3 Inch Through 48 Inch (75 mm Through 1200 mm), for Water and Other Liquids.


Y. American Water Works Association (AWWA) C800 – Stainless-Steel Pipe, 1/2 inch and Larger.


1.04 SUBMITTALS

A. Submit manufacturer’s certification that materials furnished are in compliance with applicable requirements of referenced standards and this Section.

B. Provide dimensional drawings, fabrication details, functional description, and properly identified catalog data on all items to prove complete compliance with Drawings and Specifications.

C. Submit documentation that any factory-applied primers or intermediate coatings provided on equipment or materials provided under this Section are compatible with coating system specified under Section 09 90 00.
1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE

A. Pipe:
   1. Ductile iron pipe manufactured in accordance with AWWA C150 and C151; Special thickness Class 52.
   2. Joints: Threaded flanges in accordance with AWWA C151 and ANSI Class 125 full-faced flange.
   3. Gaskets: Red rubber, with minimum thickness of 1/8 inch.
   4. Nuts and bolts: Conform to ASTM A320, Class 1, Grade 8, Type 304 with scale-free bright finish.
   5. Lining: Cement lined; coat interior surfaces in accordance with AWWA C104.
   6. Exterior coating: Coat exterior surfaces in accordance with Section 09 90 00.

B. Fittings:
   1. Flanged fittings manufactured in accordance with AWWA C110 with ANSI Class 125 full-faced flanges.
   2. Lining: Cement lined; coat interior surfaces in accordance with AWWA C104.
   3. Exterior coating: Coat exterior surfaces in accordance with Section 09 90 00.

2.02 COPPER PIPE

A. Pipe:
   1. Copper pipe according to ASTM B88, Type K, seamless, water tube, hard drawn temper.

B. Fitting:
   1. Wrought copper fitting conforming to ASTM B16.22.
   2. Joints: Compression connection or brazed AWS A5.8/A5.8M. Silver brazing filler material shall be BCuP Series, copper-phosphorus alloys for general duty brazing, unless otherwise indicated.

2.03 COUPLINGS

A. Dismantling Joints (3 inches to 16 inches)
   1. Flange spool: AWWA Class D ring flange, compatible with ANSI class 150 and 150 bolt flange pattern, or as required to make connection to equipment.
   2. End ring and body: ASTM A536 65-45-12 ductile iron.
   6. Bolts and nuts: Type 304 or 316 stainless steel.
   7. Manufacturer and model:
      b. Smith-Blair Model 975.
      c. Or equivalent.

2.04 FLANGE ADAPTERS

A. Flange Adapter
   1. Use: Use as shown on Drawings to connect plain end ductile iron pipe to flanges. Do not use in place of dismantling joints. Provide adapters with thrust restraint.
   2. Fabricate flange adapters completely from ductile iron conforming to ASTM A536.
   3. Provide with flange bolt circle pattern compatible with mating flange.
   4. Manufacturer and model:
      b. Or equivalent.
2.05 FLEXIBLE COUPLINGS

A. Provide flexible fittings to reduce pipeline noise transmission and vibrations, protect pumps and similar equipment from transmitted pipeline movement and flexing pipelines from expansions and contractions due to temperature changes, and to correct slight pipeline misalignment and torsional movement.

B. Flexible fittings: Spool-type:
   1. Construction: Molded neoprene and nylon with steel wire reinforcing. Flanges shall be one-piece, free-floating flanges, class 150, with tapped or drilled holes.
   2. Retaining rings: galvanized 3/8-inch thick split steel drilled to match flange bolt holes for spool-type couplings.
   3. Provide with manufacturer recommended number and size of tie rods.

C. Minimum design requirements:
   1. Pressure: 225 psi
   2. Vacuum: 26 in Hg
   3. Temperature: 170 degrees F.
   4. NSF 61 certified for use with drinking water.

D. Provide tie rods to prevent over elongation and failure of flexible coupling due to shock pressures.

2.06 WALL SLEEVES AND WALL PIPES

A. Wall sleeves and wall pipes shall conform to the requirements of the piping as indicated on the Drawings and as specified as follows:
   1. Cast Iron: ASTM A48, Class 30B.
   3. Mechanical Joint: AWWA C111.
   4. Integral cast or welded intermediate wall collar.

2.07 MODULAR RUBBER WALL SEALS

A. Use mechanical-type modular rubber wall seal, consisting of interlocking synthetic rubber links. The elastomeric element shall be sized and selected per manufacturer’s recommendations and have the following properties as designed:
   3. High temperature or fire seal application (minus 67 degrees F to 400 degrees F) Silicone: ASTM D2000 M1GE505.

B. Assembly of synthetic rubber link to be connected with stainless steel bolts. When bolts are tightened, pressure plates shall compress rubber links to fill annular space between pipe and wall to form a watertight seal.

C. Use modular rubber wall seals where pipes penetrate existing concrete wall and as otherwise indicated on Contract Drawings. Written approval of Engineer required for use of modular rubber seals in other locations.

D. Manufacturer: Modular rubber wall seals as manufactured by Thunderline Corporation or approved equal.
2.08 PIPE LABELS AND LETTERING

A. Provide pressure-sensitive vinyl markers indicating contents and direction of flow for all chemical piping. Color-code identification per “Des Moines Water Works Plant Piping Color Code”.
   1. Potable water (PW): White label and arrows, with Black lettering.

B. Manufacturer:
   1. Seton Identification Products.
   2. Or approved equal.

PART 3 EXECUTION

3.01 HANDLING, STORAGE, AND SHIPPING

A. Handle all pipe, fittings, and appurtenances carefully.

B. Use blocking and hold-downs during shipment to prevent movement or shifting.

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

D. Damaged pipe, fittings and appurtenances will be rejected.

E. Paint process piping and appurtenances in accordance with Section 09 90 00.

3.02 PROCESS PIPING INSTALLATION

A. Install piping and appurtenances in accordance with manufacturer’s instructions and recommendations.

B. Erect piping such that strain and weight is not on cast connections or appurtenances.

C. Pipe supports:
   1. Provide support and equipment required to control expansion and contraction of piping.
   2. Install supports as required to support piping shown on Drawings. Conform to Federal Specification WW-H-171.
   3. Support all pipe in strict accordance with pipe manufacturer’s recommendations and as acceptable to Engineer. Submit complete details of proposed support systems before fabrication and installation.
   4. Brace piping systems to withstand all loads caused by surge, water hammer, or shock.
   5. Provide supports at locations shown on Drawings.
   6. Level and plumb all pipe supports.
   7. Fill void space under base plate with grout. Refer to Concrete Materials Schedule on Plans for grout material.

D. Provide non-conducting dielectric connections wherever joining dissimilar metals.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide and install restrained flange adapters at piping connections to flanged valves to provide thrust restraint and facilitate assembly and disassembly of piping.

G. Provide clearance for access to valves and fittings.

H. Prepare pipe, fittings, supports, and accessories ready for finish painting.
I. Do not draw piping into place by applying force to flange connections or fittings and appurtenances.

J. Piping not shown or detailed on Drawings: Arrange workable layout with convenient locations for valves and appurtenances.

3.03 DISINFECTION AND TESTING

A. Disinfection of interior process piping:
   1. Swab interior surfaces of all process piping immediately prior to installation with solution containing minimum of 200 ppm of free chlorine.
   2. Protect disinfected surfaces of piping from contamination during installation.
   3. Repeat disinfection of any interior pipe surfaces suspected of having been contaminated during or immediately after installation.

B. Pressure testing:
   1. Do not connect inside process piping to buried piping until buried piping has been successfully pressure tested and disinfected.
   2. Fill inside process piping slowly and purge all air from piping system.
      a. Provide all hoses and supplemental fittings necessary to purge air from piping system.
      b. Route water that results from testing out of Process Piping Room using floor drains and access doors.
      c. Purge air slowly from piping system so as not to damage piping, instrumentation or other appurtenances.
      d. Protect electrical and other equipment from water during filling of inside process piping.
   3. Visually inspect all pipe joints for leaks after system has been filled and pressurized. Address leaks that occur.
   4. Pressure Test According to Section 33 01 13.10.

** END OF SECTION **
SECTION 40 70 00

INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1  GENERAL

1.01  SUMMARY OF WORK

A. Work under this Section includes furnishing all materials, tools, equipment, labor and supervision to install and test measurement and instrumentation devices as shown on the Contract Drawings.

1.02  RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 40 23 23 – Process Piping and Specialties.

1.03  REFERENCES


B. Underwriters Laboratories, Inc. (UL) Specifications and Standards.

1.04  SUBMITTALS

A. Submit manufacturer's certification that materials furnished are in compliance with applicable requirements of referenced standards and this Specification.

B. Provide dimensional drawings, fabrication details, functional description, and properly identified catalog data on items to document complete compliance with Drawings and Specifications.

C. Submit manufacturer's published literature and catalog cuts. Submittal should include all required data to prove compliance with Specification.

D. Submit manufacturer's installation, operation, and maintenance manuals.

1.05  MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2  PRODUCTS

2.01  GENERAL

A. All instruments which come into contact with finished drinking water shall meet the requirements of NSF 61.

B. Instrument descriptions in Valve and Equipment Schedule take precedence over this Section.
2.02 FLOW ELEMENT AND TRANSMITTER, MAGNETIC

A. Electromagnetic flowmeter with magnetic field distribution technology to provide an accurate flow reading which is highly immune to upstream flow disturbances. Flow meter to sense flow in either direction and include a rotatable LCD display.

B. Accuracy: 0.2 percent when operating in acceptable velocity range.

C. Magnetic Induction Flowmeter:
   1. Size: as indicated on the drawings.
   2. Mounting Style: Detector/converter combined, or detector/converter separate according to equipment schedule.
   3. Connection: Flanged ASME Class 150.
   4. Electrode Material: Stainless steel 316L.
   5. Lining Material: PU with NSF Certification.
   7. Flow velocity range: 1.0 to 32.8 ft/s.
   9. 4-20 mA dc output.

D. Acceptable Manufacturers:
   1. Toshiba – Flanged Mount Anywhere Meter.
   2. Or approved equal.

2.03 GAUGE PRESSURE TRANSMITTER, PRESSURE INDICATING TRANSMITTER (TYPE 1)

A. Provide direct connect in-line pressure transmitter featuring remote communications capability for measuring absolute and gauge pressure.

B. Characteristics:
   1. Output: 4-20 mA analog output.
   2. Accuracy: plus or minus 0.07 percent of span.
   3. 1/2-inch FNPT process connection.
   4. Provide with LCD display.

C. Pressure Range: 0-300 psi.

D. Supply: 12.5 – 42 vdc.

E. Electrical Safety: FM approved.

F. Instrument suitable for the following environmental conditions:
   1. Humidity: 0-100 percent relative humidity.
   2. Ambient temperature limits: minus 40 to 185 degrees F.
   3. Transmitter shall have dual-compartment housing with a moisture barrier totally isolating the electronic circuitry from field wiring and calibration terminals.

G. Options:
   1. Provide with 316 stainless steel block and bleed valve.

H. Acceptable Manufacturers:
   1. Foxboro model IGP10.
   2. Rosemount Model 2051.
   3. Or approved equal.
2.04 GAUGE PRESSURE TRANSMITTER, PRESSURE TRANSMITTER (TYPE 2)

A. Pressure transmitter with no display. Mount on suction and discharge side of each pipe.

B. Characteristics:
   1. Output: 4-20 mA analog output.
   2. Accuracy: plus or minus 0.5 percent of span.
   3. 1/4-inch NPT process connection.

C. Pressure Range:
   2. Discharge side of Pump: 0-200 psi.

D. Power supply: 9-30 VDC, 2-wire loop power.

E. Options:
   1. Provide with stainless steel block and bleed valve.

F. Acceptable Manufacturers:
   1. Wika C-10 Pressure Transmitter.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount instruments:
   1. Install instruments as shown on drawings.
   2. Locate instruments in a way which is free of vibration and interference with other piping equipment, and conduits.
   3. Mount instruments where they will be accessible from fixed ladders, platforms, or finished floor.
   4. Mount instruments with face forward toward the normal operating area.
   5. Install instruments level, plumb and rigidly supported.
   6. Ensure instruments are accessible for maintenance.

3.02 STARTUP

A. Instrument installation inspection and startup to be performed by a factory-trained representative who certifies to Engineer that equipment is properly operating and operating personnel have been properly instructed concerning operation and maintenance.

** END OF SECTION **
SECTION 40 75 21.13
FREE CHLORINE ANALYZERS

PART 1  GENERAL

1.01  SUMMARY OF WORK
A. Work under this Section includes providing and installing chlorine analyzer for monitoring free residual chlorine. Provide analyzer and all associated parts necessary for installation according to the Drawings.

1.02  RELATED SECTIONS
A. Section 01 00 00 – General Requirements for the Project.
B. Section 03 30 00 – Cast-in-Place Concrete.
C. Section 05 50 00 – Metal Fabrications.
D. Section 40 05 56 – Process Valves and Specialties.
E. Section 40 23 23 – Process Piping and Specialties.

1.03  REFERENCES (NOT USED)

1.04  CERTIFICATIONS
A. CE compliant for conducted and radiated emission, EMC Immunity EN 61326-1, and EN61010-1.
B. Ingress Protection (IP) 62 dust and water rating.
C. Underwriters Laboratories (UL) – General Purpose UL/CSA 61010-1 with cETL USafety mark.

1.05  SUBMITTALS
A. Submit manufacturer’s certification that materials furnished are in compliance with applicable requirements of referenced standards and this Specification.
B. Provide dimensional drawings, fabrication details, functional description, and properly identified catalog data on items to document complete compliance with Drawings and Specifications.
C. Submit manufacturer’s published literature and catalog cuts. Submittal should include all required data to prove compliance with Specification.

1.06  MEASUREMENT AND PAYMENT
A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2  PRODUCTS

2.01  FREE CHLORINE ANALYZERS

A. Analyzer to consist of sample and reagent valve and pump, measurement cell, and controller, and is to be shipped with buffer and indicator solutions.

B. Analyzer performance requirements:
   1. Measurement range:
      a. 0 to 5 mg/L (ppm) free or total residual chlorine.
   2. Accuracy:
      a. Plus or minus 5 percent of reading or plus or minus 0.03 mg/L (ppm), whichever is greater.
   3. Precision:
      a. 5 percent of reading or 0.01 mg/L (ppm), whichever is greater.
   4. Minimum detection limit:
      a. 0.03 mg/L (ppm).
   5. Resolution:
      a. 0.01 mg/L (ppm).
   6. Repeatability:
      a. 0.05 mg/L (ppm).
   7. Cycle Time:
      a. 2.5 minutes.

C. Equipment:
   1. The analyzer must be housed in a NEMA 12 enclosure that is IP62 rated with the gasketed door latched.
   2. Analyzer to be capable of measuring free or total residual chlorine by changing the tubing, indicator, and buffer solutions.
   3. A measurement to be taken every 2.5 minutes and results displayed by a three-digit LCD readout in the range of 0 to 5 mg/L.
   4. The analyzer must operate using 115V or 230V selectable AC power.
   5. The analyzer must perform a self-test and autoblanking between analysis points to compensate for sample color, turbidity, and changes in light intensity due to voltage fluctuations or light source aging.
   6. The analyzer to operate with an LED light source at a peak wavelength of 510nm.
   7. The analyzer must be able to operate unattended for 30 days between chemical reagent changes and measurement cell cleaning.
   8. The analyzer to have two feed control (relay) operation modes to operate chemical feed pumps. Available control options are:
      a. On/off control where the concentration alarm outputs activate or deactivate a pump when chlorine levels fall below or exceed acceptable levels.
      b. Proportional control where the 4-20mA output current is scaled to pace a feed pump proportional to output.
   9. The analyzer to have standard optically isolated analog outputs, selectable as 0/4 to 20mA, field programmable over any portion of the analyzer range.
   10. The analyzer to have two standard SPDT relay alarms, with contacts rated for 5 amp resistive loads at 230V AC power. Alarm options include concentration set point, analyzer system warning, and analyzer system shut down.

D. Required components:
   1. Standard Equipment
      a. CI17 Free or Total Chlorine analyzer.
      b. One-Month Supply of reagents.
      c. Installation kit.
      d. Maintenance kit.
e. Sample conditioning kit:
   (1) Pressure regulator, strainer, and shut off valve.
f. Wall mount kit.
g. User manual.

2. Dimensions: 13.5 by 17.9 by 7 inches (343 by 455 by 178 mm).
3. Shipping weight: 16 pounds (7.3 kg).
5. Maintenance kit with preassembled tubing.

E. Manufacturers:

2.02 MOUNTING ACCESSORS

A. Equipment to be mounted on white chemically resistant HDPE sheet with a minimum thickness of 1 inch. Supports to be stainless steel square tubes of size and thickness shown on Drawings. HDPE sheets to be attached to support tubes as shown on Drawings.

B. Ball Valves:
   1. As provided by manufacturer or plastic valves as specified in Section 40 05 56.

C. Tube:
   1. Black tube matching tube provided by equipment manufacturer.
   2. Fittings:
      a. Compression type used throughout.
      b. NSF-61 or CFR21 177.1550 compliant PVDF (Kynar) compression tube fittings for test pressure less than 50 psi, consisting of body, nut, and built-in ferrule.

D. Polyvinyl Chloride Pipe:
   1. Clear, schedule 80.
   2. Pipe and fittings manufactured from compounds that meet the requirements for Type 1, Grade 1, PVC in accordance with ASTM D2564 solvent cement.

PART 3 EXECUTION

3.01 PREPARATION

A. Mounting:
   1. Mount as indicated on Drawings.

B. Required Clearances:
   1. Horizontal: 26 inches.
   2. Vertical: 16 inches.
   3. Depth: 20 inches.

3.02 INSTALLATION

A. Contractor to install the analyzer in accordance with manufacturer’s instructions and recommendations.

B. Manufacturer’s representative will include a half-day of start-up service by a factory-trained technician.

** END OF SECTION **
SECTION 41 22 13.13
WORKSTATION BRIDGE CRANE

PART 1  GENERAL

1.01 SUMMARY OF WORK

A. Provide one (1) enclosed track, 2-ton workstation bridge crane with manual chain hoist, manual trolley, and manual bridge, supported from steel roof structure as indicated in the Drawings,

B. Provide all general requirements for the crane and hoist assembly, as defined in these Specifications and the Project Drawings, including anchorages, bracing, hangers, stops, and accessories.

C. Provide complete warranty by system manufacturer and supplier for entire crane assembly and its operation.

D. Install crane as indicated on Drawings.

1.02 SYSTEM DESIGN REQUIREMENTS

A. Manufacturer shall be responsible for providing fully operational workstation bridge crane as specified.

B. Bridge crane manufacturer shall be responsible for structural design of bridge crane members and bridge crane support requirements.

C. Design Information:

1. Design capacity 2-ton
2. High Hook Elevation 913.5 Estimated (Field Verify)
3. Ceiling Elevation (at lowest point) 916.5 See Drawings (Field Verify)
4. Low Hook Elevation (ft) 903.5 (Field Verify)
5. Hoist Type Manual Chain
6. Trolley Type Push
7. Bridge Type Push
8. Bridge Length 34 foot-10 inch See Drawings (Field Verify)
9. Bridge Width 23 feet See Drawings (Field Verify)
10. Bridge Cantilever North Side 12-inch

1.03 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 05 50 00 – Metal Fabrications.

1.04 REFERENCES

A. American Society of Mechanical Engineers (ASME):

2. ASME/ANSI B30.11 - Monorails and Underhung Cranes.

B. American Society for Testing and Materials (ASTM):

1. ASTM A36 – Structural Steel.
2. ASTM A48 – Gray-Iron Casting.
3. ASTM A148 – Steel Casings, High-Strength, for Structural Purposes.
5. ASTM A668 – Steel Forgings, Carbon and Alloy, for General Industrial Use.
6. ASTM B221 – Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.

C. Crane Manufacturers Association of America (CMMA).
D. American Welding Society (AWS).
E. Occupational Safety and Health Administration (OSHA).
   1. 1910.179 – Overhead and Gantry Cranes.
F. Forging Industry Association Handbook.

1.05 SUBMITTALS
A. Submit the following items for materials provided by Contractor:
   1. Manufacturer’s certification that materials furnished are in compliance with applicable
      requirements of referenced standards and this Section.

B. Provide dimensional drawings, fabrication details, functional description, and properly identified
   catalog data on crane and accessories to prove complete compliance with Drawings and
   Specifications. Drawings should show complete system to coordinate the final layout and support
   design. Show plan and elevation view, crane runway, hoist, trolley, headroom, pendant, and
   supports.

C. Provide complete drawings and details for erection and installation.
D. Provide test results from load tests.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Store and handle crane to prevent warping or cracking of members.
B. Protect all components from damage by weather and operations on the site.

1.07 MEASUREMENT AND PAYMENT
A. Include all material, equipment, labor, and associated work necessary to complete the work described
   in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.

PART 2 PRODUCTS

2.01 WORKSTATION BRIDGE CRANE
A. General requirements:
   1. Conform to CMMA No. 74 and ASME B30.11, except as otherwise indicated.
   2. Conform to requirements for crane as shown on Drawings.
   3. Trolley hoist for use with this crane shall be provided as specified in this section.

B. Structural Design:
   1. Use enclosed-track style steel runway and bridge specifically designed and manufactured for
      overhead crane application.
   2. Bridge to consist of single or double girder mounted on end trucks with all structure connections
      welded or assembled with high-strength bolts.
   3. Provide end trucks specifically designed for use with an enclosed track crane.
   4. Use ceiling-mounted underhung type crane.
C. Mechanical Design:
   1. Use crane designed so that it is readily accessible for maintenance lubrication and inspection. Provide with all necessary lubricating fittings. Wheels hubs shall be comprised with permanently lubricated ball bearings. Lubricate all bearings, gears, and other items requiring lubrication before placing crane in operation.
   2. Bridge Type: Manual (push).
   3. Provide bridge bumpers conforming to CMMA No. 74.

D. Use manufacturer’s standard paint system.

E. Placards: Locate placards indicating rated capacity of bridge crane on both sides of crane and in a position clearly visible from floor of operation.

F. End Stops: Molded composite, resilient bumper installed in runway and bridge tracks to prevent end trucks and hoist trolley from rolling out of track. Bolt stops without energy absorbing bumper are not acceptable.

G. Manufacturers:
   1. Gorbel, Inc.
   2. SPANCO, Inc.
   3. Or approved equal.

2.02 TROLLEY HOIST ASSEMBLY

A. General requirements:
   1. Conform to ANSI/ASME B30.16 except as otherwise indicated on the Drawings.
   2. Conform to requirements for individual cranes and trolley hoist as indicated in System Design Requirements section of this Specification.
   3. Use paint system standard for manufacturer.
   4. Permanently mark rated capacity on each side of unit.
   5. Provide with stainless steel chain.

B. Manual Chain Hoist:
   1. Type: As indicated in System Design Requirements section of this Specification.
   2. Use units suitable for operation on the specified bridge crane.

PART 3 EXECUTION

3.01 PREPARATION

A. Inspect all areas and surfaces for conditions which may inhibit proper installation. Do not proceed with installation until conditions are satisfactory.

3.02 INSTALLATION

A. Provide a complete installation including all materials and equipment necessary for operation of the equipment. Place all specified equipment into operation, including machinery lubrication.

B. Install bridge crane level and in alignment.

C. Adjust equipment to operate properly, including adjustment of stops to prevent over travel, and tension to prevent travel when not in use.

D. Touch-up damaged paint surfaces with matching paint system.
E. Lubricate all bearings, gears, and other items requiring lubrication before placing crane into operation.

F. Coordinate bridge crane supports between precast specialty engineer responsible for hollow-core plank design and supplier of the bridge crane. General Contractor shall be responsible for coordinating the two parties to ensure proper support of the bridge crane and appropriate installation of supports in precast roof planks.

3.03 TESTING

A. Prior to initial use and at other intervals until date of acceptance, test crane for a load capacity of 125 percent of manufacturer’s rated capacity as required by Occupational Safety and Health Administration Part 1910.179(k)(2).

B. Send copies of test report to Owner and place on file at Project site.
   1. Testing to be performed by persons authorized to perform tests.

** END OF SECTION **
SECTION 43 23 13
OVERHUNG HORIZONTAL CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. This Section describes requirements for the horizontal split case pumps for the NW 26th Street Booster Station and associated testing, delivery, and start-up services.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.
B. Section 05 50 00 – Metal Fabrication.
C. Section 40 23 23 – Process Piping and Specialties.

1.03 REFERENCES

L. Hydraulic Institute (HI) – Standards for Centrifugal, Rotary and Reciprocating Pumps.
M. Institute of Electrical and Electronics Engineers (IEEE) Standard Test Procedure for Polyphase Induction Motors and Generators.

O. National Electrical Manufacturer’s Association (NEMA) Standards.

P. Occupational Safety and Health Act of 1970 (Public Law 91-596) (OSHA).

Q. Steel Structures Painting Council Surface Preparation Specification No. 6 – Commercial Blast Cleaning (SSPC-SP6).


1.04 SUBMITTALS

A. Provide equipment, dimensional drawings, and properly identified catalog data on all components and other necessary information and cross-references to prove complete compliance with Specifications.

B. Furnish following information on pumping equipment:
   1. Pump:
      a. Make, model number, capacity-head, rotation speed, and efficiency.
      b. Description of pump, baseplate, construction, and materials.
      c. Performance curves: Indicate discharge, head, efficiency, NPSH required, submergence required to prevent vortices, and brake horsepower required under various conditions of operation.
      d. Special requirements for suction piping or suction well to prevent vortices and optimize operation of pump.
   2. Motor:
      a. Make and model number.
      b. Description of type, design, construction, enclosure type, rotation, and materials.
      c. Horsepower, frame number, sound pressure level, operating voltage, and speed.
      d. Temperature rating, service factor, full load, 3/4-load, and 1/2-load efficiency, and power factor.
      e. Weight, shaft diameter, type of bearings, bearing manufacturer and part number(s), and cooling and lubrication requirements.
   3. Installation instructions.
   4. Certified performance curves, test reports, and shop vibration readings.
   5. Written start-up report.

C. See Section 01 00 00 for additional requirements.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2 PRODUCTS

2.01 PUMP

A. Provide three (3) single-stage horizontal centrifugal, close coupled or short long coupled, end suction pumps with motor, base, and accessories. Acceptable manufacturers and models:
   1. Fairbanks Morse Pump Corporation.
   2. Flowserve Pump Division, Mark 3.

B. Pump requirements:
   1. “Pumps, as an assembled unit, shall be certified to NSF/ANSI Standard 61 and 372 and meet the requirements of the US Safe Drinking Water Act of 2014”.
      a. Manufacturer will be responsible for informing Engineer if materials or equipment specified do not meet NSF 61.
   2. Pumps suitable for use with chlorinated water.
   3. Continuous duty.
   4. Variable speed.
   5. Liquid pumped: potable water.
      a. Specific gravity: 1.0.
      b. Temperature range: 34 degrees F to 80 degrees F.

C. Hydraulic performance parameters:
   1. Design capacity: 500 gallons per minute (0.72 mgd).
   2. Design total dynamic head: 110 feet.
   3. Minimum run-out head (rated diameter): 650 gallons per minute.
   4. Minimum continuous stable flow: no higher than 125 gallons per minute at full speed.
   5. Minimum efficiency at design capacity and total dynamic head: 65 percent.
   6. Pump curve to rise continuously from run-out head to shutoff head.

2.02 MATERIALS OF CONSTRUCTION

A. Casing: cast iron (ASTM A48, Class 30) or ductile iron (ASTM A536, Grade 60-40-18).

B. Impeller: bronze (ASTM B148, C95800) or stainless steel (ASTM A743 Grade CF8M).


D. Shaft Sleeve: bronze or stainless steel.

2.03 CASING

A. Close coupled end suction with tapped holes for vent, drain, suction and discharge pressure gauges.

B. Provide for easy disassembly of rotating elements without disturbing casing suction and discharge.

C. Volute type with recesses to ensure alignment.

D. Support casing from below by fabricated mounting stand or base plate.

2.04 IMPELLER

A. Single-suction, enclosed-type impeller, hydraulically and dynamically balanced to ANSI/HI standards.

B. One-piece design, finished smooth, and free of burrs.
C. Secure impeller to shaft by key of ample size and lock in place.

D. Use an impeller suitable for continuous use with chlorinated drinking water.

2.05 SHAFT SLEEVES

A. Equip with replaceable shaft sleeve to minimize shaft wear.

B. Seal to prevent pumped liquid from contact with shaft; Buna-N rubber O-ring.

2.06 CASING WEAR RINGS

A. Fit pump casing with casing wear rings to minimize abrasive and corrosive wear to casing.

B. Lock rings in place to prevent rotating, using pins from corrosion-resistant material.

2.07 SHAFT SEAL

A. Pumps to include a self-flushing mechanical steel seal.

B. Single face mechanical seals with stainless steel metal parts, Buna-N elastomer parts, ceramic seat and carbon washer suitable for continuous operation.

2.08 SHAFT

A. One-piece, finished, and polished on all sections.

B. Diameter sufficient to allow no greater than 0.002-inch deflection at the seal faces at any point of operation on pump curve.

C. Renewable shaft sleeves to protect shaft from wear and from contact with the pumped liquid.

2.09 BEARINGS

A. Shaft bearing to carry all radial and thrust loads.

B. Rolling element-type bearings installed in sealed housing that retains lubricant and excludes dirt and moisture.

C. Design bearing housing for oil lubrication; supply with constant level oilers.

D. Lubrication to meet requirements of ANSI/NSF Standards 60/61.

2.10 MOTOR

A. Type: TEFC, premium efficiency, inverter duty, horizontal, solid shaft, continuous duty, squirrel cage induction motor capable of driving specified pump when connected to motor controller.

B. Design, manufacture, assemble, and test in accordance with the latest applicable standards of NEMA, ANSI, IEEE, ASTM, and National Electrical Code.

1. Design for variable speed control by insulated-gate bipolar transistor (IGBT) pulse width modulated, 10:1 variable torque, variable frequency drive (VFD) and full voltage starting with a VFD drive bypass contactor.

2. Design for inverter duty conforming to requirements of NEMA MG-1, Part 30 and Part 31.
C. Acceptable manufacturers:
   1. Weg Industries.
   2. Baldor Electric.
   3. TECO-Westinghouse.
   5. Or approved equal.

D. Horsepower: 25 horsepower.

E. Rotative speed: nominal 1800 rpm; bidirectional rotation; match speed required of pump.

F. Voltage: 480 volts AC, 3 phase, 60 hertz.

G. Service factor: 1.15 on sine wave power, 1.0 on pulse width modulated power.

H. Insulation: inverter grade Class F; meet NEMA Standard MG-1, Part 31.

I. Temperature rise: Class B over 40 degrees C ambient temperature.

J. Main terminal box: Match construction of motor enclosure; rotatable in 90-degree increments; provide ample room for motor leads and power supply wiring; include space for mounting of mechanical lug terminals and internal wiring; locate at easily accessible location on motor enclosure.

K. Hardware: 18-8 stainless steel conforming to ASTM A276.

L. Nameplate: stainless steel; include all information required by NEMA.

M. Guaranteed minimum full load efficiency: Meet or exceed minimum efficiency value listed in Efficiency Table in NEMA MG 1; NEMA Nominal Efficiency must meet or exceed minimum rebate levels for premium efficiency motors established by the Consortium for Energy Efficiency (CEE) and other criteria set by MidAmerican Energy Company to receive rebate from MidAmerican Energy Company.

N. Provide with shaft grounding ring to prevent any currents from grounding through the bearings.

2.11 NAMEPLATES AND DATA PLATES

A. Mount nameplates and data plates on pump and motor.

B. Mount nameplate on motor clearly explaining how magnetic center of the motor is determined in the field.

2.12 PAINTING

A. Paint according to manufacturer’s standard.

B. Prime and coat motor enclosure with standard color.

2.13 TOOLS AND SPARE PARTS

A. Furnish special tools required for operation and maintenance of equipment furnished.

B. Furnish spare mechanical seal of each size furnished.

C. Furnish one set of gaskets, O-rings, grommets, and other sealing devices.
PART 3  EXECUTION

3.01  GENERAL

A. Requirements
   1. Manufacture and assemble, close coupled end suction pump units.
   2. Provide specified start-up services.

3.02  INSTALLATION

A. Install as recommended by manufacturer.

B. Pump and motor to be mounted on a concrete foundation base using bolts into threaded inserts to allow removal of drive motor without disturbing the pump liquid end or the piping. If pump is provided with baseplate grout baseplate according to Section 05 50 00.

C. Install suction and discharge piping. Do not transmit any excessive force to pump flanges.

3.03  START-UP SERVICES

A. Provide services of factory-field representative for minimum of 2 full days on site to:
   1. Instruct Contractor on installation.
   2. Install mechanical seals.
   3. Inspect installation prior to start-up, adjust, and witness start-up.

B. Provide additional 1/2 day of on-site service to instruct Owner's operating personnel about proper use and maintenance of furnished equipment.

C. Provide copy of written start-up report.

** END OF SECTION **
PART 1 GENERAL

1.01 SUMMARY OF WORK

A. This Section describes requirements for the horizontal split case pumps for the NW 26th Street Booster Station and associated testing, delivery, and start-up services.

1.02 RELATED SECTIONS

A. Section 01 00 00 – General Requirements for the Project.

B. Section 05 50 00 – Metal Fabrication.

C. Section 40 23 23 – Process Piping and Specialties.

1.03 REFERENCES


K. Hydraulic Institute (HI) – Standards for Centrifugal, Rotary and Reciprocating Pumps.

L. Institute of Electrical and Electronics Engineers (IEEE) Standard Test Procedure for Polyphase Induction Motors and Generators.

M. International Standards Organization (ISO) Standard 1940/1 – Balance Quality Requirements of Rigid Rotors.
N. National Electrical Manufacturer’s Association (NEMA) Standards.

O. Occupational Safety and Health Act of 1970 (Public Law 91-596) (OSHA).

P. Steel Structures Painting Council Surface Preparation Specification No. 6 – Commercial Blast Cleaning (SSPC-SP6).


1.04 SUBMITTALS

A. Provide equipment, dimensional drawings, and properly identified catalog data on all components and other necessary information and cross-references to prove complete compliance with Specifications.

B. Furnish following information on pumping equipment:
   1. Pump:
      a. Make, model number, capacity-head, rotation speed, and efficiency.
      b. Description of pump, baseplate, construction, and materials.
      c. Performance curves: Indicate discharge, head, efficiency, NPSH required, submergence required to prevent vortices, and brake horsepower required under various conditions of operation.
      d. Weight, thrust, stuffing box pressure, deflection at seal faces, bearing loads, and predicted bearing life.
      e. Special requirements for suction piping or suction well to prevent vortices and optimize operation of pump.
   2. Motor:
      a. Make and model number.
      b. Description of type, design, construction, enclosure type, rotation, and materials.
      c. Horsepower, frame number, sound pressure level, operating voltage, and speed.
      d. Wiring diagrams for motor, space heaters, surge protection equipment, and RTDs.
      e. Temperature rating, service factor, full load, 3/4-load, and 1/2-load efficiency, and power factor.
      f. Weight, shaft diameter, type of bearings, bearing manufacturer and part number(s), and cooling and lubrication requirements.
      g. Type and method of coupling to pump.
      h. Thrust capacities of bearings.
   3. Installation instructions.
   4. Certified performance curves, test reports, and shop vibration readings.
   5. Written start-up report.

C. See Section 01 00 00 for additional requirements.

1.05 MEASUREMENT AND PAYMENT

A. Include all material, equipment, labor, and associated work necessary to complete the work described in this Section in the Lump Sum Bid on the Proposal for the NW 26th Street Booster Station.
PART 2  PRODUCTS

2.01  PUMP

A. Provide two (2) pumps with single-stage centrifugal horizontal split-case pump, motor, base, coupling, OSHA-compliant guards, and accessories. Acceptable manufacturers and models:
1. Fairbanks Morse Pump Corporation, 2800 Series.
2. Flowserve Pump Division, Type LR or LNN.

B. Pump requirements:
1. “Pumps, as an assembled unit, shall be certified to NSF/ANSI Standard 61 and 372 and meet the requirements of the US Safe Drinking Water Act of 2014”.
   a. Manufacturer will be responsible for informing Engineer if materials or equipment specified do not meet NSF 61.
2. Pumps shall be suitable for use with chlorinated water.
3. Continuous duty.
4. Variable speed.
5. Liquid pumped: potable water.
   a. Specific gravity: 1.0.
   b. Temperature range: 34 degrees F to 80 degrees F.
7. Suction size, minimum: 8 inches.
8. Discharge size, minimum: 6 inches.
10. Rotation: according to Contract Drawings.

C. Hydraulic performance parameters:
1. Design capacity: 2,500 gallons per minute (3.6 mgd).
2. Design total dynamic head: 200 feet.
3. Minimum run-out head (rated diameter): 3,000 gallons per minute.
4. Minimum continuous stable flow: no higher than 1,000 gallons per minute at full speed.
5. Minimum efficiency at design capacity and total dynamic head: 80 percent.
6. Pump curve to rise continuously from run-out head to shutoff head.

2.02  MATERIALS OF CONSTRUCTION

A. Casing: cast iron (ASTM A48, Class 30) or ductile iron (ASTM A536, Grade 60-40-18).
B. Impeller: bronze (ASTM B148, C95800) or stainless steel (ASTM A743 Grade CF8M).
D. Shaft Sleeve: bronze or stainless steel.
E. Case Wear Ring: cast iron (ASTM A48, Class 30), bronze (ASTM A148, C89835) or stainless steel (ASTM A743 Grade CF8M).
F. Impeller Wear Ring: bronze (ASTM B505, AL932) or stainless steel (ASTM A744 Grade CF8M).

2.03  CASING

A. Horizontal split case, twin-volute design with tapped holes for priming, vent, and drain. Minimum working pressure: 300 psig.
B. Casing consisting of upper- and lower-half casings containing volute and suction passages. Pin casing halves to ensure alignment of the stuffing box faces.
C. Removal of upper half of the casing must allow removal of rotating element without disconnecting the suction or discharge piping.

D. Provide removable bearing housing machined flat and precision doweled, and securely bolted to lower half of casing. Machine and assemble replaceable inboard and outboard bearing housings without need for field alignment.

E. Provide suitable taps in high-pressure section of casing and stainless-steel tubing for external flushing lines for mechanical seals.

F. Each bearing arm will provide an open top reservoir area between the seal and the bearing housing for accumulation of weepage from the stuffing box, and a drilled and tapped opening will be provided at the lower portion to allow piping to the nearest drain.

2.04 IMPELLER

A. Enclosed, double suction-type impeller, hydraulically and dynamically balanced to ISO 1940/1 Balance Quality Grade 2.5.

B. One-piece design, finished smooth, and free of burrs.

C. Secure impeller to shaft by key of ample size and lock in place between the shaft sleeves using shaft sleeve nuts. Extend impeller key into both shaft sleeves for positive engagement.

D. Press impeller wear rings on impeller hubs and secure with set screws installed parallel to the shaft.

E. Use an impeller suitable for continuous use with chlorinated drinking water.

2.05 SHAFT SLEEVES

A. Extend shaft sleeves from hub of impeller through seal box area. Retain sleeves and impeller using shaft-sleeve nuts.

B. Seal to prevent pumped liquid from contact with shaft; threaded seal designed to lock impeller; Teflon-coated steel gasket or Buna-N rubber O-ring.

2.06 CASING WEAR RINGS

A. Fit pump casing with casing wear rings to minimize abrasive and corrosive wear to the casing.

B. Fit pump with renewable case wear rings; radial type with machined shoulders to match machined shoulders in casing to provide two sealing faces.

C. Lock rings in place to prevent rotating, using pins fabricated from Monel or other corrosion-resistant material.

2.07 STUFFING BOX

A. Machine stuffing box into casing.

B. Design with sufficient space for incorporation of either packing rings or mechanical seals.

C. Fit stuffing boxes with split-seal mechanical seals. Acceptable manufacturers:
   1. Flowserve Pump Division, PSSIII.
   2. Chesterton Global Solutions, 442.
   3. Or approved equal.
2.08 SHAFT

A. One-piece, finished, and polished on all sections.

B. Shaft shall be of ample strength and rigidity and the shortest practicable distance between bearings shall be used to keep deflection and vibration to a minimum.

C. Diameter sufficient to allow no greater than 0.002-inch deflection at the seal faces at any point of operation on pump curve.

D. Renewable shaft sleeves to protect shaft from wear and from contact with the pumped liquid.

2.09 BEARINGS

A. Single-row inboard bearing and double-row outboard bearing; design for radial and thrust loads; design for minimum 100,000 hours average life.

B. Mount bearings in machined, moisture- and dust-proof housing that has a flat, machined face to match the casing and is aligned using precision dowel pins. Bearing housing replacement shall be accomplished without the need to drill and ream new taper pin holes for re-alignment of the bearing housing to the casing.

C. Design-bearing housing for oil lubrication; supply with constant level oilers.

D. Lubrication to meet the requirements of ANSI/NSF Standards 60/61.

2.10 MOTOR

A. Type: TEFC, premium efficiency, inverter duty, horizontal, solid shaft, continuous duty, squirrel cage induction motor capable of driving pump specified pump when connected to motor controller.

B. Design, manufacture, assemble, and test in accordance with the latest applicable standards of NEMA, ANSI, IEEE, ASTM, and National Electrical Code.
1. Design for variable speed control by insulated-gate bipolar transistor (IGBT) pulse width modulated, 10:1 variable torque variable frequency drive (VFD) and full voltage starting with a VFD drive bypass contactor.
2. Design for inverter duty conforming to requirements of NEMA MG-1, Part 30 and Part 31.

C. Acceptable manufacturers:
1. Weg Industries.
2. Baldor Electric.
3. TECO-Westinghouse.
5. Or approved equal.

D. Horsepower: 200 horsepower.

E. Rotative speed: nominal 1800 rpm; bidirectional rotation; match speed required of pump.

F. Voltage: 480 volts AC, 3 phase, 60 hertz.

G. Service factor: 1.15 on sine wave power, 1.0 on pulse width modulated power.

H. Enclosure: cast iron frame, end bells and inner and outer bearing caps, open drip-proof; stainless steel screens; conform with definition of enclosure as stated in NEMA Section MG 1-1.25; coat enclosure with corrosive duty mill and chemical duty paint.
I. Shaft: 1045 carbon steel.

J. Bearings: rated for minimum L-10 life of 20,000 hours; grease-lubricated ball bearings to carry weight of motor rotor.


L. Temperature rise: Class B over 40 degrees C ambient temperature.

M. NEMA code letter: G.

N. NEMA design letter: B; conform to values listed in NEMA Standard MG1, Table 21.5; capable of delivering the pull-out torque for at least 1 minute; as required to start and drive pump; allow for 10 percent voltage dip during starting.

O. Space heaters: 120 volts, single phase; minimum 300W; terminate leads in easily accessible auxiliary conduit box on motor enclosure.

P. Resistance temperature detectors (RTDs) for use with grounded control circuit:
   1. Type: Class F, precision platinum, 100 ohm plus 5 percent at 0 degrees C with 0.003926 ohm/ohm/degrees C temperature coefficient of resistance; three leads.
   2. Bearing temperature: two RTDs, one for drive-end bearing and one for opposite drive-end bearing.
   3. Motor winding temperature: three RTDs, one for each motor winding; locate sensors near hottest point of windings.
   4. Terminate all leads on terminal blocks in auxiliary terminal box; do not ground any lead at machine.

Q. Main terminal box: Match construction of motor enclosure; rotatable in 90-degree increments; provide ample room for motor leads and power supply wiring; include space for mounting of mechanical lug terminals and internal wiring; locate at easily accessible location on motor enclosure.

R. Auxiliary terminal box: Constructed of pressed steel sheets; provide ample room and suitable terminal blocks for termination of RTDs leads and space heater leads; isolate space heater terminations from RTDs terminations; locate at easily accessible location on motor enclosure.

S. Hardware: 18-8 stainless steel conforming to ASTM A276.

T. Nameplate: stainless steel; include all information required by NEMA.

U. Guaranteed minimum full load efficiency: Meet or exceed minimum efficiency value listed in Efficiency Table in NEMA MG 1-12.53b; perform efficiency testing in accordance with IEEE Standard 112, Test Method B, using accuracy improvement by segregated loss determination including stray load loss improvement as specified in NEMA MG 1-12.53A; identify NEMA Nominal Efficiency on motor nameplate; NEMA Nominal Efficiency must meet or exceed minimum rebate levels for premium efficiency motors established by the Consortium for Energy Efficiency (CEE) and other criteria set by MidAmerican Energy Company to receive rebate from MidAmerican Energy Company.

V. Provide with shaft grounding ring.
2.11 COUPLING

A. Provide flexible disc coupling with drop-out spacer to connect pump to motor shaft.
   1. Consider frequent speed changes under load and use with variable frequency drive when determining service factor for coupling. Minimum service factor: 1.25.
   2. Balance coupling to meet AGMA Class 9 requirements.
   3. Minimum spacer length: as recommended by pump manufacturer.
   4. Acceptable models and manufacturers:
      b. KD21 by Kop-Flex, Inc.

B. Provide OSHA compliant coupling guard.

2.12 BASEPLATE

A. Mount pump and motor on single, groutable, structural baseplate fabricated from steel conforming to ASTM A36.

B. Provide machined-mounting surfaces for all pump and motor mounting feet.

C. Provide grout holes to permit filling entire cavity under the baseplate without creating air pockets.

D. Provide transverse and axial alignment positioning jack screws to facilitate transverse and longitudinal adjustments for motor.

E. Provide sufficient number of drilled and tapped holes in bottom flange of perimeter structural steel for vertical leveling jack screws capable of supporting weight of baseplate, pump, and drive-train components without excessive deflection.
   1. Include additional vertical leveling jack screws adjacent to anchor bolts to minimize distortion of baseplate during installation.

F. Provide sufficient number of lifting lugs to lift baseplate, complete with pump and drive-train components mounted, without:
   1. Permanently distorting or otherwise damaging baseplate.
   2. Damaging pump or drive-train components.

2.13 NAMEPLATES AND DATA PLATES

A. Mount nameplates and data plates on pump and motor.

B. Mount nameplate on motor clearly explaining how magnetic center of the motor is determined in the field.

2.14 PAINTING

A. Paint according to manufacturer’s standard.

B. Prime and coat motor enclosure with standard color.

2.15 BASEPLATE GROUT

A. Grout according to Specification Section 05 50 00 Section 2.05 A.

2.16 TOOLS AND SPARE PARTS

A. Furnish special tools required for operation and maintenance of equipment furnished.

B. Furnish spare mechanical seal of each size furnished.
C. Furnish one set of gaskets, O-rings, grommets, and other sealing devices.

D. Furnish one-year supply of lubricant.

E. Furnish stainless steel anchor bolts, anchorages, nuts, and washers required for complete installation per manufacturer's instruction.

PART 3 EXECUTION

3.01 GENERAL

A. Requirements
   1. Manufacture, assemble, factory test, and furnish horizontal split case pumping units.
   2. Provide specified start-up services.

B. Alternates
   1. All pumping equipment that can approximately meet specified design conditions will be considered.
   2. All accessories that are standard for specified equipment have to be furnished even though same accessories may not be standard on proposed alternate equipment.
   3. Owner will be sole and final judge as to suitability/acceptability of alternate equipment and materials.
   4. Obtain approval of alternative pump equipment prior to bidding.

3.02 FACTORY TESTS

A. Test pumps at factory using unwitnessed test described in Hydraulic Institute (H.I.). Include:
   1. Unwitnessed performance test: Provide readings of minimum of five capacity points; include readings at design point and pump run-out.
   2. Hydrostatic test of pump casing assembly with certificate.

B. Vibration, when measured in the direction of maximum amplitude on pump and motor bearing housings, shall not exceed limits given in the latest ANSI/HI nomograph for the applicable pump type.

C. Submit electronic copy of certified factory test reports to Engineer for review; do not deliver equipment until certified factory test reports have been reviewed and marked by Engineer.

3.03 INSTALLATION

A. Install as recommended by manufacturer.

B. Baseplate Installation:
   1. Removed cement-rich laitance from top of concrete foundation for pump and motor.
   2. Remove all oil, dirt, flakes, fragments, and moisture from chipped surface using oil-free air.
   3. Rig base plate using lifting lugs provided. Lift in manner that will prevent deformation of base plate.
   4. Place base plate on concrete foundation over anchor bolts.
   5. Confirm enough clearance under base plate flange to allow minimum of 2 inches of grout thickness.
   6. Level base plate. Do not use anchor bolts as levelers.
   7. Use machinist's level graduated in 0.0005-inch increments and a precision-ground parallel bar to determine levelness.
   8. Level base plate until each individual machined mounted pad is level to within:
      a. 0.002 inches/foot for pump-mounting pads.
      b. 0.005 inches/foot for motor mounting pads.
   9. Level to be determined with base plate in unrestrained condition.
C. Check alignment of pump and motor.
   1. If alignment is deficient remove deformation from base plate by additional leveling, then realign pump and motor.

D. Grout in anchor bolts and baseplate.

E. Torque foundation anchor bolts. Monitor base plate at each anchor bolt to determine if movement occurs during application of torque.

F. Align motor shaft to pump shaft by adding or removing stainless steel shims under motor feet and moving motor horizontally as required.

G. Install suction and discharge piping. Do not transmit any excessive force to pump flanges.

H. Recheck pump and motor shaft alignment and coupling.

3.04 START-UP SERVICES

A. Provide services of factory-field representative for minimum of 2 full days on site to:
   1. Instruct Contractor on installation.
   2. Install mechanical seals.
   3. Inspect installation prior to start-up, make adjustments, and witness start-up.

B. Provide additional 1/2 day of on-site service to instruct Owner’s operating personnel about proper use and maintenance of furnished equipment.

C. Provide copy of written start-up report.

** END OF SECTION **