SPECIFICATIONS
for
PHASE 1
FUEL TANK REPLACEMENT FOR EMERGENCY GENERATOR AND DISTRIBUTION UPGRADES

GRIFFIN HOSPITAL
130 Division Street
Derby, Connecticut

CONSTRUCTION DOCUMENTS

vZ# 2021144.01

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SUGGESTED SEQUENCE OF CONSTRUCTION

CONTRACTOR METHOD OF PROCEDURE

1. Contractor is responsible to develop a Method of Procedure (MOP) to detail out the steps to undertake for each part of their work. MOP must be presented to, and approved by the Owner and the Engineer prior to commencing with any work described here-in.

EARLY PHASE

1. Coordinate all trades so an expedited installation can occur without any delays due to improper planning and coordination.

FUEL SYSTEM INSTALLATION

1. Re-route Comcast fiber line to not be impacted by removal of existing and installation of new fuel tanks.

2. Disconnect and remove existing 6000-gallon fuel tank, and piping into the generator room.

3. Install new 20,000-gallon fuel tank, piping and tank monitoring system into generator room. Abandon in place existing piping that extends to existing fuel transfer package. (assumes that temporary fuel system is in place and operational, connected to existing generators).

4. Provide testing of tank, all exterior piping and monitoring for new tank installation.

END of SUGGESTED SEQUENCE OF CONSTRUCTION

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SECTION 010000 – GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents apply to this Section. This Section applies to all work performed under the contract.

1.2 PROJECT REQUIREMENTS

A. Project Identification: The Griffin Hospital Emergency Generator and Distribution Upgrades, Derby, Connecticut.

B. Permits and Fees: Apply for, obtain, and pay for permits and fees required to perform the work.

C. Codes: Comply with applicable codes and regulations of authorities have jurisdiction.

D. Dimensions: Verify dimensions indicated on drawings with field dimensions before fabrication or ordering of materials. Do not scale drawings.

E. Existing Conditions: Notify Engineer of existing conditions differing from those indicated on the drawings.

F. Contractor’s Conduct on Premises: The Contractor and his employees shall behave in a respectful, courteous and safe manner. Abusive, harassing, and lewd behavior is prohibited. Music playing is prohibited. Alcohol, tobacco and drug use is prohibited.

1.3 SPECIFICATION INFORMATION

A. These specifications are a specialized form of technical writing edited from master specifications and contain deviations from traditional writing formats. Capitalization, underlining and bold print is only used to assist reader in finding information and no other meaning is implied.

B. Except where specifically indicated otherwise, the subject of all imperative statements is the Contractor.

C. Sections are generally numbered in conformance with Construction Specifications Institute Masterformat System. Numbering sequence is not consecutive. Refer to the table of contents for names and numbers of sections included in this Project.

D. Pages are numbered separately for each section. Each section is noted with "End of Section" to indicate the last page of a section.

1.4 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. “Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Provide": Furnish and install, complete and ready for the intended use.

1.5 INDUSTRY STANDARDS

A. Referenced standards are part of the Contract Documents and have the same force and effect as if bound with these specifications.

B. Except where specifically indicated otherwise, comply with the current standard in effect as of the date of the Owner/Contractor Agreement. Obtain copies of industry standards directly from publisher.

C. The titles of industry standard organizations are commonly abbreviated; full titles may be found in *Encyclopedia of Associations*.

1.6 CODES AND REGULATIONS

A. Comply with all applicable codes, ordinances, regulations and requirements of authorities having jurisdiction.

B. Submit copies of all permits, licenses, certifications, inspection reports, releases, notices, judgments, and communications from authorities having jurisdiction to the Engineer.

1.7 SCHEDULE OF VALUES

A. Prepare Schedule of Values to coordinate with application for payment breakdown. Submit at least (10) days before first payment application. Update and reissue regularly, but not less than monthly.

1.8 PAYMENT REQUESTS

A. Provide three copies of each request on completely filled out copies of AIA G702 and continuation sheet G703. Substantiate requests with complete documentation; include change orders to date. Provide partial lien waivers for work in progress and full lien waivers for completed work.

B. Record Drawing Certification: Certify as a part of each application for payment that the project record documents are current at the time of application is submitted. The Contractor shall require such drawings to be current as a condition of approving any payment to the trade Contractor and Subcontractor.

C. Before first payment application, provide the following:

1. List of subcontractors, suppliers and fabricators.
2. Schedule of values.
3. List of Contractor’s key project personnel.
4. Copies of permits and other communications from authorities.
5. Contractor’s certificate of insurance.

D. Before final payment application, provide and complete the following:

1. Complete closeout requirements.
2. Complete punch list items.
3. Settle all claims.
4. Transmit record documents to Engineer.
5. Prove that all taxes, fees and similar obligations have been paid.
6. Remove surplus materials.
7. Clean the work.
8. Submit consent of surety, if any, for final payment.

1.9 PROCEDURES AND CONTROLS

A. Project Meetings: Arrange for and attend meetings with the Engineer and such other persons as the Engineer requests to have present. The Contractor shall be represented by a principal, project manager, general superintendent or other authorized main office representative, as well as by the

Contractor's field superintendent. An authorized representative of any subcontractor or sub-subcontractor shall attend such meetings if the representative's presence is requested by the Engineer. Such representatives shall be empowered to make binding commitments on all matters to be discussed at such meetings, including costs, payments, change orders, time schedules and manpower. Any notices required under the Contract may be served on such representatives. Written reports of meeting minutes shall be prepared by the Contractor and distributed by the Contractor to attendees, the Engineer, and Owner within (3) business days.

1. Pre-Construction Conference: Attendance by Engineer, Contractor, major subcontractors. Agenda shall include: Quality of workmanship, coordination, interpretations, job schedule, submittals, approvals, requisition procedures, and testing.
2. Progress Meetings: Hold regularly before preparation of payment requests and additional meetings as requested by the Engineer. Attendance by Engineer, Contractor, and others as determined by Contractor. Agenda shall include work in progress and payment requests.

B. Emergency Addresses: Furnish the Owner and Engineer, in writing, the names addresses and telephone numbers of individuals to be contacted in the event of an out-of-hours emergency at the building site. Post a similar list readily visible from the outside of the field office or a location acceptable to the Engineer.

C. Field Measurements: Verify measurements at the building prior to ordering materials or commencing work. No extra charge or compensation will be allowed because of differences between actual dimensions and measurements indicated on the Drawings. Differences that may be found shall be submitted to the Engineer for decision before proceeding with the work.

D. Field Measurements for Fixed Equipment: Dimensions for fixed equipment to be supplied under this Contract or separate contracts shall be determined by field measurements taken jointly by the Contractor and the equipment supplier involved. A record of the field measurements shall be kept until time of substantial completion of the project, or until the equipment has been fully installed and accepted by the Owner, whichever is later. Responsibility for fixed equipment fabricated accurately to field measurements for proper fit and operation shall be that of the Contractor. Contractor shall pay all costs involved in correcting any misfitting fixed equipment as fabricated.

E. Matching: Where matching is indicated, the Engineer shall be the sole and final judge of what is an acceptable match.

F. Observation: Notify the Engineer and authorities having jurisdiction at least (36) hours in advance of concealing any work.

G. Utilities: Prior to interrupting utilities, services or facilities, notify the utility owner and the Owner and obtain their written approval a minimum (10) days in advance. Contractor shall strive to minimize service interruptions by grouping together any required outages.

H. Off-Hours Work: All work that will interrupt electrical power, including any work on live branch circuit panelboards and/or wireways, shall be performed outside of the normal business hours of 6:00AM to 8:00PM, Monday through Friday.

I. Clean-Up: Frequently clean-up all waste, remove from site regularly, and legally dispose of offsite.

J. Installer's Acceptance of Conditions: All installers shall inspect substrates and conditions under which work is to be executed and shall report in writing to the Contractor all conditions detrimental to the proper execution and completion of the work. Do not proceed with work until unsatisfactory conditions are corrected. Beginning work means installer accepts previous work and conditions.

1.10 SUBMITTALS

A. Required Submittals: Submit shop drawings, product data, initial selection samples, verification samples, calculations, schedules, and all other submittals as specified in individual specification sections.

B. Contractor's Preparation of Submittals: Modify and customize all submittals to show interface with adjacent work and attachment to building. Identify each submittal with name of project, date, Contractor's name, subcontractor's name, manufacturer's name, submittal name, relevant specification section numbers, and Submittal Schedule reference number. Stamp and sign each submittal to show the Contractor's review and approval of each submittal before delivery to Engineer's office; unstamped and unsigned submittals will be returned without action by the Engineer. Leave 4" x 6" open space for Engineer's "action" stamp.

C. Product Data: Provide manufacturer's preprinted literature including, without limitation, manufacturer's standard printed description of product, materials and construction, recommendations for application and use, certification of compliance with standards, instructions for installation, and special coordination requirements. Collect data into one submittal for each unit of work or system; mark each copy to show which choices and options are applicable to project.

1. Electronic Submittals: Identify and incorporate information in each electronic submittal file.
    a. Electronic Submittals: Submit in accordance with requirements of Project website submittals procedures.
    b. Assemble complete submittal package into a single submittal, incorporating submittal requirements of a single Specification Section.

D. Shop Drawings - Electronic: Identify and incorporate information in each electronic submittal file as follows:

1. Electronic Submittals: Submit in accordance with requirements of Project website submittals procedures.
2. Assemble complete submittal package into a single submittal, incorporating submittal requirements of a single Specification Section.
3. Metadata: Include the following information as keywords in the electronic submittal metadata:

a. Project name.
b. Number and title of appropriate Specification Section.
c. Manufacturer name.
d. Product name.

E. Timing of Submittals: Submit submittals in a timely fashion to allow at least (10) business days for each office's review and handling. This means that submittals that have to be reviewed by the Engineer and one of his consultants require at least (20) business days for review and handling. Add (10) business days for each additional consultant who must review a submission.

F. Engineer's Action on Submittals: Engineer will review submittals, stamp with "action stamp", mark action, and return to Contractor. Engineer will review submittals only for conformance with the design concept of the project. The Contractor is responsible for confirming compliance with other Contract requirements, including without limitation, performance requirements, field dimensions, fabrication methods, means, methods, techniques, sequences and procedures of construction, coordination with other work. The Engineer's review and approval of submittals shall be held to the limitations stated in the Owner Agreement and the Conditions of the Contract. In no case shall approval or acceptance by the Engineer be interpreted as a release of Contractor of his responsibilities to fulfill all of the requirements of the Contract Documents.

1. Required Resubmittal: Unless submittal is noted "reviewed and approved" or "reviewed and approved except as noted, resubmission not required," make corrections or changes to original and resubmit to Engineer.
2. Distribution: When submittal is marked "approved" or "approved as noted, resubmittal not required," make prints or copies and distribute to Owner, Subcontractors involved, and to all other parties requiring information from the submittal for performance or coordination of related work. Print shop drawings for distribution only from the final approved copy.

1.11 WARRANTIES

A. Warranties Required: Refer to individual trade sections for specific product warranty requirements.

B. Procurement: Where a warranty is required, do not purchase or subcontract for materials or work until it has been determined that parties required to countersign warranties are willing to do so.

C. Warranty Forms: Submit written warranty to Owner through Engineer for approval prior to execution. Furnish (2) copies of executed warranty to Owner for his records; furnish (2) additional conformed copies where required for maintenance manual.

D. Work Covered: Contractor shall remove and replace other work of project which has been damaged as a result of failure of warranteed work or equipment, or which must be removed and replaced to provide access to work under warranty. Unless otherwise specified, warranty shall cover full cost of replacement or repair, and shall not be pro-rated on basis of useful service life.

E. Warranty Extensions: Work repaired or replaced under warranty shall be warranted until the original warranty expiration date or for (90) days whichever is later in time.

F. Warranty Effective Starting Date: Guarantee period for all work, material and equipment shall begin on the date of substantial completion, not when subcontractor has completed his work nor when equipment is turned on. In addition to the one-year guarantees for the entire work covered by these Contract Documents, refer to the various sections of the specifications for extended guarantee or maintenance requirements for various material and equipment.

1.12 CUTTING AND PATCHING

A. Limitations: Do not cut and patch any work in a manner that would result in a failure of the work to perform as intended, decreased energy performance, increased maintenance, decreased operational life, or decreased safety.

1. Structural Work: Do not cut structural work or bearing walls without written approval from Engineer. Where cutting and patching of structural work is necessary and approved by Engineer, perform work in a manner that will not diminish structural capacity nor increase deflection of member. Provide temporary shoring and bracing as necessary. Ensure the safety of people and property at all times.

B. Cutting and Patching Materials: Use materials identical to materials to be cut and patched. If identical materials are not available or cannot be used, use materials that match existing materials to the greatest extent possible. Provide finished work that will result in equal to or better than existing performance characteristics.

C. Inspection: Before cutting and patching, examine surfaces and conditions under which work is to be performed and correct unsafe and unsatisfactory conditions prior to proceeding.

D. Protection: Protect adjacent work from damage. Protect the work from adverse conditions.

E. Cutting: Cut work using methods least likely to damage adjoining work. Use tools designed for sawing or grinding, not hammering or chopping. Use saws or drills to ensure neat, accurately formed holes to sizes required with minimum disturbance to adjacent work. Temporarily cover openings; maintain weathertightness and safety.

F. Patching: Patch with seams and joints that are durable and not visible. Comply with specified tolerances for similar new work; create true even planes with uniform continuous appearance. Restore finishes of patched areas and, if necessary, extend finish restoration onto adjoining unpatched area to eliminate evidence of patching and refinishing. Repaint entire assemblies, not just patched area. Remove and replace work that has been cut and patched in a visually unsatisfactory manner as determined by the Engineer.

G. Qualifications: Retain experienced and specialized firms, original installers if possible, to perform cutting and patching. Workmen shall be skilled in type of cutting and patching required.

1.13 DELIVERY, STORAGE AND HANDLING

A. Manufacturer's Instructions: Strictly comply with manufacturer's instructions and recommendations and prevent damage, deterioration and loss, including theft. Minimize longterm storage at the site. Maintain environmental conditions, temperature, ventilation, and humidity within range permitted by manufacturers of materials and products used.

1.14 LABELS

A. Labels, Trademarks and Trade names: Locate required labels on inconspicuous surfaces. Do not provide labels, nameplates, or trademarks that are not required. Provide permanent data plate on each item of equipment stating manufacturer, model, serial number, capacity, ratings and all other essential data.

1.15 RECORD DOCUMENTS

A. General: Keep record documents neatly and accurately. Record information as the work progresses and deliver to Engineer at time of final acceptance. Include in record documents all field changes made, all relevant dimensions, and all relevant details of the work. Keep record documents up to date with all field orders and change orders clearly indicated.

B. Drawings: Keep (2) separate sets of black line prints at the site, one set each for electrical and architectural/structural disciplines. Neatly and accurately note all deviations from the Contract Documents and the exact actual location of the work as installed. Marked-up and colored prints will be used as a guide to determine the progress of the work installed. Requisitions for payment will not be approved until the record documents are accurate and up-to-date.

1. At completion of the work, submit one complete set of marked-up prints for review. After acceptance these marked-up prints shall be used in the preparation of the record drawings.
2. Engineer shall furnish Contractor with AutoCAD files for originals of the Contract Drawings. Make modifications to these files as shown on the marked-up prints. Remove superseded data to show the completed installation.
3. Deliver the completed AutoCAD record drawings, in the same version as Contract Drawings, properly titled and dated to the Engineer. Indicate preparer of record drawings. These record drawings shall become the property of the Owner.

C. Specifications: Maintain one clean copy of complete specifications (including addenda, modifications, and bulletins) with changes, substitutions, and selected options clearly noted. Circle or otherwise clearly indicate which manufacturer and products are actually used.

D. Operating and Maintenance Manuals: Manuals shall be submitted which contain the following:

1. Description of the system provided.
2. Handling, storage, and installation instructions.
3. Detailed description of the function of each principal component of the systems or equipment.

4. Operating procedures, including prestartup, startup, normal operation, emergency shutdown, normal shutdown and troubleshooting.
5. Maintenance procedures including lubrication requirements, intervals between lubrication, preventative and repair procedures, and complete spare parts list with cross reference to original equipment manufacturer’s part numbers.
6. Control and alarm features including schematic of control systems, control loop electric ladder diagrams, controller operating set points, settings for alarms and shutdown systems, pump curves and fan curves.
7. Safety and environmental considerations.

E. Copies of Operating and Maintenance Manuals: (3) copies of the manuals shall be provided within sufficient time to allow for training of Owner's personnel. Submit one copy of the manuals to the Engineer for review no later than (90) calendar days prior to substantial completion, or building turn over, whichever comes first. Submit the remaining (5) copies within (15) days after first review set is returned to Contractor. Progress payment may be withheld if this requirement is not met.

F. Additional Requirements for Operating and Maintenance Manuals: The requirements for manuals applies to each packaged and field-fabricated operating system. The manuals shall be provided in three-ring side binders with durable plastic covers. The manuals shall contain a detailed table of contents and have tab dividers for major sections and special equipment.

1.16 PROJECT CLOSE OUT

A. Complete the following prior to Substantial Completion:

1. Provide Contractor's Punch List of incomplete items stating reason for incompletion and value of incompletion.
2. Advise Owner of insurance change over requirements.
3. Submit all warranties, maintenance contracts, final certificates and similar documents.
4. Obtain Certificate of Occupancy and similar releases which permit the Owner's full and unrestricted use of the areas claimed "Substantially Complete".
5. Submit record documents.
6. Complete startup of all systems and instruct Owner's personnel in proper operation and routine maintenance of systems and equipment.
7. Complete clean up and restoration of damaged finishes.
8. Request Engineer's inspection for Substantial Completion.

B. Engineer will either issue a Certificate of Substantial Completion or notify Contractor of work which must be performed prior to issue of certificate.

C. Complete the following prior to Final Acceptance and payment:

1. Obtain Certificate of Substantial Completion.
2. Submit final application for payment, showing final accounting of changes in the work.
3. Provide final releases and lien waivers not previously submitted.

4. Submit certified copy of final punch list stating that Contractor has completed or corrected each item.
5. Submit Consent of Surety for final payment.
6. Submit evidence of Contractor's continuing insurance coverage (if required by Contract Documents).

1.17 FINAL CLEANING AND REPAIR

A. Clean Up: Immediately prior to the Engineer's inspection for Substantial Completion, the Contractor shall completely clean the premises and clean and prepare the completed work in order for it to be used for its intended purpose in accordance with the Contract Documents. Such work shall include, but not be limited to the following:

1. Concrete and ceramic surfaces shall be cleaned and washed.
2. Resilient coverings shall be cleaned, waxed and buffed as applicable.
3. Woodwork shall be dusted and cleaned.
4. Sash, fixtures and equipment shall be thoroughly cleaned.
5. Stains, spots, dust, marks and smears shall be removed from all surfaces.
6. Hardware and metal surfaces shall be cleaned and polished.
7. Glass and plastic surfaces shall be thoroughly cleaned by professional window cleaners.
8. Damaged, broken or scratched glass or plastic shall be replaced by the Contractor at the Contractor's expense.
9. Vacuum carpeted and soft surfaces.

B. Repairs: Repair and touch-up all damaged and deteriorated products and surfaces.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION 010000

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SECTION 03100 - CONCRETE FORMWORK

PART I - GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including General and Supplementary General conditions and Division 1, General Requirements apply to the work specified in this section. Note also all Addenda.

1.2 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment and appliances to furnish and install all concrete formwork.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Concrete Reinforcement: Section 03200
Cast-In-Place Concrete: Section 03300

1.4 QUALITY ASSURANCE

A. All materials and work shall conform to the requirements of all standards, codes, and recommended practices required in this section. In conflicts between standards, required standards, and this specification, the more stringent requirements shall govern.

B. Applicable Standards:

1. ACI 347(Latest Revision) - “Recommended Practice for Concrete Formwork”
2. ACI 301 (Latest Revision) - “Specifications for Structural Concrete for Buildings”

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms shall be constructed of the following materials as indicated for the use and purpose intended:

1. For unexposed surfaces and rough work, undressed lumber may be used. Lumber once used in forms shall have nails withdrawn, and surfaces to be I contact with concrete shall be thoroughly cleaned before being used again.

2. For exposed exterior sides of foundations walls which show exposed above grade, and surfaces of walls, columns, and slabs to be left exposed in the finished building, forms lined with plastic coated plywood or masonite shall be used. All joints shall be filled with suitable joint filler in order to produce a reasonable straight, smooth surface, free from honeycombs, bulges, and depressions.
3. Form ties and spreaders shall be of such type as to leave no metal closer than ¾" from exposed concrete surfaces and 1½" from unexposed surfaces, below grade.

B. Expansion joints - premolded expansion joint filler shall conform to one of the following:

1. ASTM D 1751 (Latest Revision) -"Standard Specifications for Preformed Expansion Joint Fillers for Concrete paving and Structural Construction" (Nonextruding and resilient bituminous types).

2. ASTM D 1752 (Latest Revision) – "Standard Specifications for Preformed Expansion Joint Fillers for Concrete Paving and Structural construction" (Nonextruding and resilient nonbituminous types).

PART 3 - EXECUTION

3.1 ERECTION

A. Forms shall conform to the shapes, lines, grades and dimensions of the members as called for on the drawings. They shall be erected with sufficient strength, bracing and ties as to remain in correct position during and after depositing of concrete. They shall be substantially free from surface defects and sufficiently tight to prevent leakage of mortar. They shall produce a plumb, true, even concrete surface. Lumber in forms for exposed surfaces shall be dressed and free form loose knots or other defects. Undressed lumber may be used for rough work or unexposed surfaces. They shall permit thorough cleaning and inspection before depositing of concrete.

B. Form ties and spreaders shall be of such type as to leave no metal closer than ¾" from exposed concrete surfaces. Tie rod holes shall be plugged solid with a mortar of same color and texture as the concrete.

C. Forms, if oiled, shall be coated with a non-staining mineral oil or other approved material and allowed to dry before placing of reinforcing steel.

D. Forms shall not be disturbed until the concrete has sufficiently hardened to prevent injury by this operation. All forms, except permanent metal forms, shall be removed when the concrete is thoroughly hardened. Forms for walls shall be left in place for a minimum of three days.

E. Provide ¾" chamfers at all exposed concrete edges if shown by Architectural Drawings.

F. Shoring, posts or uprights shall not be removed until the supported member has acquired sufficient strength to support safely its own weight and all loads upon it. Re-shoring will not be permitted. Members subjected to additional loads during construction shall be adequately shored or braced. Contractor shall assume responsibility for any damage to the structure due to premature removal of forms or inadequate bracing.

G. Sleeves shall not be formed into any structural member unless shown on structural drawings.

H. Construction Joints, when not shown on working drawings shall be made and located to least impair the strength of the structure.

1. All reinforcement shall be continued across joints and keys shall be provided.

2. Slabs on Fill: Joints shall be located so that slabs can be poured in or cut into panels, each panel not exceeding 900 square feet in area. The ratio of length to width shall not exceed 3.

3. Foundation Walls: Vertical joints shall be placed at intervals not exceeding 75 feet. Horizontal joints shall not be permitted.

I. Expansion Joints - premolded expansion joint filler shall be placed along edges of slab on grade where abutting foundation walls, and at all other locations as detailed.

J. Control joints shall be as shown on the working drawings and as directed by the Architect.

1. Contraction joints may be formed, tooled or sawed approximately equal to ¼ the thickness of the member.

K. Erect formwork to produce concrete members conforming to the following dimensional tolerances:

1. Variations from plumb in the lines and surfaces of columns, piers, and walls shall not exceed ¼” in any 10 feet of height nor 1” for entire length.

2. Variation of linear building lines from established position in plan shall not exceed 1”.

3. Variation in cross-sectional dimensions of columns and beams and in thickness of slabs and walls shall not exceed minus ¼”, nor plus ½”.

END OF SECTION 03100

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SECTION 03200 - CONCRETE REINFORCEMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including General and Supplementary Conditions and Division 1, General Requirements apply to the work specified in the section. Note also all Addenda.

1.2 DESCRIPTION OF WORK

A. Furnish and erect in place all reinforcing steel and welded wire fabric as indicated on Drawings. Include all splices, ties, supports, and other accessories required to properly place and secure all reinforcing during placing of concrete.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

Concrete Form Work: Section 03100
Cast-In-Place Concrete: Section -03300

1.4 SUBMITTALS

A. Shop Drawings: Contractor shall prepare detailed drawings showing dimensions, bar schedules, bending details and placing diagrams and details, for all reinforcement. Drawings shall be submitted for approval and no reinforcement shall be placed before drawings are approved.

1.5 QUALITY ASSURANCE

A. All work shall conform to the requirements of the following:

1. ACI 318 (Latest Revision) - “Building Code Requirements for Reinforced Concrete”
2. ACI 315 (Latest Revision) - “Manual of Standard Practice for Detailing Reinforced Concrete Structure:
3. ACI 301 (Latest Revision) “Specifications for Structural Concrete for Buildings”

PART 2- PRODUCTS

2.1 MATERIALS:

A. Steel Reinforcement: Reinforcing bars shall be new domestic with a minimum fy = 60,000 psi; and shall conform to the requirements of “Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement” (ASTM A615-Latest Revision).

B. Wire Fabric: Welded wire fabric for concrete reinforcement shall conform to the requirements of "Specifications for Welded Steel Wire Fabric for Concrete Reinforcement" (ASTM A185).

C. Bar supports shall have CRSI " Rust Prevention Classification" as listed:

1. Unexposed: Concrete beams, slabs, etc. - Class "A".
2. Exposed: Concrete beams, slabs, and soffits, etc. - Class "C".

PART 3 - EXECUTION

3.1 FABRICATION AND SITE STORAGE

A. Reinforcing shall be accurately formed to dimensions on drawings details, and schedules within the following tolerances:

Sheared Length …..……..+ or - 1 inch
Stirrups, Ties and Spirals……+ or - ½ inch
All other bends……..+ or - 1 inch

B. Fabrication shall not commence until details and schedules have been approved by the Architect.

C. Reinforcement shall be bent cold and shall not be straightened or rebent in a manner than will injure the materials. Bars with bends or kinks not shown on Drawings shall not be used. Bars shall be stored on site, off of the ground and separated by individual groups that shall be tagged for ease of identification. Bundles shall be securely wrapped to prevent separation prior to placement.

3.2 PLACING REINFORCEMENT

A. Metal reinforcement shall be secured against displacement with suitable ties or clips and all accessories such as chairs, metal bar-supports, bolsters, etc., which come in contact with exposed concrete surface shall have Rust Prevention Classification "C" and shall have plastic coated bearing surfaces.

B. Welded wire fabric shall be lapped 8" at ends and sides and the upper layer shall be placed within 1" of the top of the slab and to be held in place by high chairs at 4'-0" o/c maximum, this includes welded wire fabric in slabs-on-grade.

C. Metal reinforcement, at the time concrete is placed, shall be free from mill scale, rust, or other coatings that will reduce bond.

D. Metal reinforcement shall have a protection of concrete not less than the following:

1. Three inches (3”) at sides and on bottoms of footings.
2. Two inches (2”) where concrete is exposed to weather or to the ground after removal of forms for bars larger than #5 and one and one-half inches (1 ½”) for #5 bars and smaller.
3. One and one-half inches (1 ½”) in columns, beams and girders not exposed to the weather.
4. Three fourths inch (3/4”) in slabs, joists and walls not exposed to the weather.

E. Metal reinforcement shall be accurately bent, spliced, and placed to dimensions shown on he Drawings and in accordance with the latest specifications of the American Concrete Institute. Bars shall be tied at all intersections.

END OF SECTION 03200

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SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for concrete pavement and walks.
2. Section 33053 “Miscellaneous Cast-in-Place Concrete

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.
e. Special concrete finish Subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form removal limitations, shoring and reshoring procedures, anchor rod and anchorage device installation tolerances, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Architect.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Fiber reinforcement.
5. Waterstops.
6. Curing compounds.
7. Floor and slab treatments.
8. Bonding agents.
9. Adhesives.
10. Vapor retarders.

B. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

C. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

D. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

C. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

1.8 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301
2. ACI 117

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    a. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    b. Structural 1, B-B or better; mill oiled and edge sealed.
    c. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.

D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

E. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2.3 STEEL REINFORCEMENT

A. Plain-Steel Wire: ASTM A 1064/A 1064M, galvanized.

B. Deformed-Steel Wire: ASTM A 1064/A 1064M.

C. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, plain-steel wire, with less than 2 percent damaged coating in each 12-inch wire length.

D. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.

F. Galvanized-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from galvanized-steel wire into flat sheets.

G. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain steel.

2.4 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars, ASTM A 775/A 775M epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

D. Zinc Repair Material: ASTM A 780/A 780M.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

2.5 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, Type I/II, gray.

C. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 3S, Class 3M, Class 1N coarse aggregate or better, graded. Provide aggregates from a single source with documented service

record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

F. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

G. Water: ASTM C 94/C 94M and potable.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork].

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Combined Fly Ash and Slag Cement: 50 percent portland cement minimum, with fly ash not exceeding 25 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 to 1.00 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Slabs-on-Grade: Normal-weight concrete.

1. Minimum Compressive Strength: 3500 psi or as otherwise required at 28 days.
2. Maximum W/C Ratio: 0.50.
3. Minimum Cementitious Materials Content: 470 lb/cu. yd.
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Do not chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 REMOVING AND REUSING FORMS

A. General: Formwork for sides of housekeeping pads, slabs and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

3.3 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, until placement of section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.4 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

2. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
3. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
4. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

3.5 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.

1. Apply scratch finish to surfaces such as sidewwalks and similar pathways.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces such as housekeeping pads and similar.
2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

3.6 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4500 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

B. Inspections:

1. Steel reinforcement placement.
2. Curing procedures and maintenance of curing temperature.
3. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172/C 172M shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. Yd, but less than 25 cu. yd, plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231/C 231M, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567/C 567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

END OF SECTION 033000

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. This contract includes all labor, materials, equipment and appliances necessary to complete all cast-in-place concrete as indicated on the drawings or hereinafter specified.

B. Anchor bolts, leveling plates, sleeves, inserts, hangers, etc. furnished under other divisions and required to be cast into the concrete shall be set by this Contractor where required.

C. Provide all concrete bases, curbs, mats, pads, trenches, slots, openings, etc., as required by any or all of the drawings; Architectural, Site, Structural, Plumbing, Heating and Ventilating, and Electrical, and to accommodate equipment or work of all the divisions of these specifications.

D. Provide thickened slabs on grade with flush top surfaces where required to accommodate conduit, piping, etc... Consult structural and mechanical drawings for conditions and maintain minimum 1 ½" thickness of concrete below conduit and full slab on grade thickness above conduit. Provide required thickness of gravel below such thickened slabs.

E. Vapor retarder, seam tape, pipe boots, and detail strip for installation under concrete slabs.

1.3 RELATED REQUIREMENTS:

1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.
2. Section 321313 "Concrete Paving" for concrete pavement and walks.
3. Section 03100 “Concrete Formwork”
4. Section 03200 “Concrete Reinforcement

1.4 QUALITY ASSURANCE

A. Materials and work shall conform to the requirements of all standards, codes, and recommended practices required in this section. In conflicts between standards, required standards and this specification and the local building code, the ore stringent requirements shall govern.

B. Applicable Standards:

1. "Specifications for Structural Concrete for Buildings" ACI 301-(Latest Edition)
2. “Building Code Requirement for Structural Concrete" ACI 318- (Latest Edition)
3. "Standard Specification for Ready-Mixed Concrete" ASTM C 94- (Latest Edition)

C. Testing and Inspection:

1. Testing Agency shall be State of Connecticut approved, independent, and certified Testing Agency engaged by the Contractor.
2. Materials and operations shall be tested and inspected as work progresses. Failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate the Architect for final acceptance.
3. Testing agencies shall meet the requirements of "Recommended Practices for Inspection and Testing Agencies for Concrete and Steel in Construction" ASTM E 329- (Latest Edition).
4. The following testing services shall be performed by the designated agency, paid for by the Contractor.
   a. Secure composite samples in accordance with "Method of Sampling Fresh Concrete" ASTM C 172- (Latest Edition).
   b. Mold and cure three specimens from each sample in accordance with "Method of Making and Curing Concrete Test Specimens in the Field" ASTM C 31-(Latest Edition).
   c. Test Specimens in accordance with "Method of Test for Compressive Strength of Cylindrical Concrete Specimens" ASTM C 39-(Latest Edition). Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information.
   d. Make one strength test for each 50 cu. Yd. or fraction thereof, of each mix design of concrete placed in any one day.
   e. Determine slump for each strength test and whenever consistency of concrete appears to vary, using "Method of Test for Slump of Portland Cement Concrete". ASTM C 143-(Latest Edition).
   f. Determine total air content of normal-weight concrete sample for each strength test in accordance with "Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method". ASTM C 231- (Latest Edition).
   g. Determine temperature of concrete sample for each strength test.
   h. Unit weight, yield and air content (gravimetric) of concrete. ASTM C 138.

5. The contractor shall provide and pay for the necessary testing services of the following:
   a. Qualification of proposed materials and the establishment of mix design in accordance with "Building Code requirements for Structural Concrete" ACI 318-(Latest Edition).

   b. Other testing services needed or required by the Contractor.

6. To facilitate testing and inspection, the contractor shall:
   a. Furnish necessary labor to assist testing agency in obtaining and handling samples at the job-site.

b. Advise the testing agency in advance of operations to allow for the assignment of testing personnel and testing.
c. Provide and maintain for the use of he testing agency adequate facilities for proper curing of concrete test specimens on the project site in accordance with "Method of Making and Curing Concrete Test Specimens in the Field" ASTM C 31- (Latest Edition).

D. Evaluation and Acceptance:

1. The strength level of the concrete will be considered satisfactory if 90% of the strength test results and the averages of all sets of three consecutive strength test results equal or exceed specified strength and no individual test result is below specified strength by more than 500 psi.

1.5 SUBMITTALS

A. Submit copies of two laboratory trial mix designs proposed in accordance with Method 1, ACI 301- (Latest Edition), or copies each of 30 consecutive test results and the mix design used from a record of past performance in accordance with ACI 301-Latest Revision, Method 2.

B. Submit copies of all concrete cylinder test results.

C. Submit copies of fine and coarse aggregate sieve analysis showing conformance to this specification.

D. Submit copies of specifications for each product proposed for use as listed in Part 2 of this section.

E. Submit vapor retarder samples, installation instructions for placement, seaming and pie boot installation, and independent laboratory test results showing compliance with ASTM and ACU Standards.

PART 2 - PRODUCTS

2.1 CONCRETE AND RELATED MATERIALS

A. Portland Cement; Type I conforming to ASTM C 150- (Latest Edition). Cement used in the work shall correspond to that upon which the selection of concrete proportions was based. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent.

1. Only one brand and manufacturer of approved cement shall be used for exposed concrete.
2. Type III cement shall be used only with prior written approval from the Architect.

B. Aggregates; conforming to ASTM C 33- Latest Revision and C330- Latest Revision for lightweight aggregates used in lightweight concrete.

1. Fine aggregate: clean, sharp, natural sand free from loam, clay, or other deleterious matter.
2. Coarse aggregate, clean, uncoated, graded aggregate containing no clay, loam or foreign matter.
3. Pre-soak aggregates used in lightweight concrete.

C. Water; shall be fresh, and drinkable.

D. Concrete admixtures; provide admixtures used in compliance with manufacturers recommendations.

1. Air-entraining agent; conforming to ASTM C 260- (Latest Edition), MB-AE 10, or MB-VR, manufacturer by Master Builders, or approved equal as manufactured by Sonnoborne, Euclid, or W. R. Grace Companies.
2. Water-reducing; set-controlling admixture; conforming to ASTM C 494- (Latest Edition), Type A (water-reducing), Type D (water-reducing and retarding) and Type E (water-reducing, acceleration), manufacturer by Master Builders, Sonnoborne, Euclid or W. R. Grace Companies.

E. Metal Accessories; shall conform to the requirements of the Concrete Reinforcing Steel Institute (CRSI) "Manual Construction".

F. Expansion Joint; conforming to ASTM D 1751 or ASTM D 1752.

G. Curing Materials; exceeding the requirements of ASTM C 309-(Latest Edition) "Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete". "MB-429" manufactured by Master Builders, or approved equal manufactured by Sonnoborne, Euclid or W. R. Grace Companies.

1. Material providing water retention not exceeding loss of .055 gm/cm2 when used at a coverage of 450 sq. ft. per gallon and tested in accordance with ASTM C 156.
2. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. Grout: Non-shrink, "SETGROUT" as manufactured by Master Builders.

I. Vapor barrier: shall be polyethylene manufactured product for use as vapor retarder beneath interior concrete slabs on grade. It shall be installed per ASTAM E 1643 and in widest practical width. All joints shall be lapped a minimum of six (6) inches, and all breaks or holes shall be patched prior to pouring the concrete.

1. Vapor retarder must have the following qualities:
   a. Maximum permeance of 0.01 perms.
   b. Minimum thickness of 0.01 in (10 mils).

c. Manufacturer of selected product must provide documentation that clearly illustrates submitted water vapor retarder product meets or exceeds the above requirements in accordance with ASTM E 1745 and ASTM F 710.

2. Vapor retarders:
   a. Stego Wrap (10 mil) Vapor Retarder by Stego Industries, LLC, San Juan Capistrano, CA.
   b. SealTight Vapor-Mat by W.R. Meadows.
   c. Moistop Ultra "C" by Fortifiber Building Services Group, Reno, Nevada

J. Curing paper shall be the approved equal of Sisalkraft Paper "Orange Label" that conforms with ASTM C171, Type I.

K. Provide Dampproofing from top of footing to the finished grade for foundations that retain earth and enclose interior spaces and floor below grade where waterproofing is not required. Dampproofing shall be the approved equal Sonnoborne Building Products' Hydrocide 700B that complies to ASTM D-1227, Type I.

L. Premolded joint filler shall be a preformed bituminous expansion type that conforms to ASTM D-994. Joint material thickness shall be one-half (1/2) inch thick, except as otherwise indicated on the drawings.

M. Waterstops: shall be installed in all vertical foundation wall construction joints when finished floor is below finished grade elevation. All waterstops to be (minimum) 6" PVC material.

N. Concrete Moisture Vapor Reduction Admixture: to be used in all cast-in-place concrete interior slabs on grade, elevated slabs, and stair treads and landings creating a chemical reaction to form a permanent barrier (capillary break) which is integral to the concrete; conforming to ASTM E 96 (Latest Edition) and ASTM C494 (Latest Edition). Barrier-1; Moxie 1800 Super Admix; Vapor Lock VL 20/20, or approved equivalent.

1. Concrete moisture vapor reduction admixture must have the following qualities:
   a. Water Vapor Transmission: E-08 cm/sec per ASTM D 5084
   b. Appearance: Colorless
   c. Odor: None
   d. Toxicity: None
   e. Flammability: None
   f. Solvent: Water
   g. Hazardous Vapors: None
   h. Capillary Break: Calcium Silicate Hydrate Gel
   i. Installation: All concrete
   j. VOC Levels: Zero
   k. Anti-microbial biocide (mold and bacteria growth inhibitor)

2.2 SELECTION OF CONCRETE PROPORTIONS

A. Concrete shall be composed of Portland Cement, fine and Coarse aggregate, water, Pozzolith admixture, and as specified, an air-entraining admixture. Proportions of ingredients shall produce concrete which will work readily into corners and angles of forms, bond to reinforcement, without segregation or excessive bleed water forming on the surface. Proportioning of materials shall be in accordance with ACI 211.1-Latest Revision, "Recommended Practice for Selecting Proportions for Normal Weight Concrete" and AC1211.2-Latest Revision "Recommended Practice for Selecting Proportions for Structural Lightweight Concrete".

1. Proportions of ingredients shall be selected by past field experience or by laboratory trial mixes to produce placability, durability, strength and the additional properties specified.

B. Required average strength above specified strength shall be determined in accordance with ACI 318-Latest Revision "Building Code Requirements for Structural Concrete" and evaluations of compressive strength results of field concrete shall be in accordance with ACI 214-Latest Revision "Recommended Practice for Evaluation of Strength Test Results of Concrete".

1. Past field Experience; proportions shall be established on the actual field experience of the ready-mix produced with the materials proposed to be employed. Standard deviation shall be determined by 30 consecutive tests (or two groups of tests totaling 30 or more).
   a. Average strength used for selecting proportions shall exceed specified strength (f'c) by at least:

      400 psi - standard deviation is less than 300
      550 psi - standard deviation is 300 to 400
      700 psi - standard deviation is 400 to 500
      900 psi - standard deviation is 500 to 600
      1200 psi - standard deviation is above 600 or unknown

2. Trial Mixes; when the ready-mix producer does not have a record of past performance, the combination of materials and the proportions selected shall be selected from trial mixes having proportions and consistencies suitable for the work based on ACI 211.1-Latest Revision, using at least three different water-cement ratios which will produce a range of strengths encompassing those required.
   a. Average strength required shall be 1200 psi above specified strength.

2.3 CONCRETE QUALITIES REQUIRED

A. Specified minimum compressive strength at 28 days shall be 3,500 psi for footings and foundations walls, and 4,000 psi for exterior slab-on-grades unless noted on the drawings.

B. Concrete subject to exposure shall be air-entrained. Total air content required (air-entrained and entrapped air) shall be:

Nominal Max. Size Coarse Aggregate	Total Air Content
¾"	6% + or - 1
1"	5% + or - 1
½"	4% + or - 1

C. Concrete shall be proportioned and produced to have a slump, not to exceed 4 in. if consolidation is by vibration or 5 in. if consolidation is by other means.

D. Slump for concrete flatwork shall be 1" less than specified above.

E. Maximum size of coarse aggregate shall not exceed one-third the thickness of slabs, and one-fifth the narrower dimension between forms.

F. Concrete shall be adjusted to produce the required rate of hardening for varied climatic and job-site conditions.

1. Under 50oF ambient temperature - Accelerate (Approval in Writing Required from the Architect) (Type E Admixture - ASTM C 494-Latest Revision)
2. Between 50oF and 80oF - Normal rate of Hardening (Type A Admixture - ASTM C 494-Latest Revision1)
3. Over 80oF ambient temperature - Retard (Type B Admixture - ASTM C 494-Latest Revision)

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR-RETARDER INSTALLATION

A. Install, protect, and repair vapor retarders according to ASTM E1643; place sheets in position with longest dimension parallel with direction of pour.

1. Lap joints 6 inches and seal with manufacturer's recommended adhesive or joint tape.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

3.6 CONCRETE PLACEMENT

A. Comply with ACI 301 for placing concrete.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

C. Do not add water to concrete during delivery, at Project site, or during placement.

D. Consolidate concrete with mechanical vibrating equipment according to ACI 301.

E. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
3. Minimum Compressive Strength: 5000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor them into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding 1/2 inch.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch.

1. Apply to concrete surfaces exposed to public view.

C. Rubbed Finish: Apply the following rubbed finish, defined in ACI 301, to smooth-formed-finished as-cast concrete where indicated:

1. Smooth-rubbed finish.
2. Grout-cleaned finish.
3. Cork-floated finish.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.

1. Do not further disturb surfaces before starting finishing operations.

C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes unless otherwise indicated.

D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.

E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.

F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

G. Slip-Resistive Broom Finish: Apply a slip-resistive finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 305.1 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

a. Water.
b. Continuous water-fog spray.
c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests: Perform according to ACI 301.

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

END OF SECTION 033053

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SECTION 230500 – COMMON WORK RESULTS FOR MECHANICAL

PART 1 - GENERAL

1.1 REFERENCES

A. Refer to the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and applicable parts of DIVISION 1 for other general requirements. These requirements may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall NOT be construed to reduce the requirements of those Divisions NOR to eliminate other requirements under those Divisions.

B. The requirements of this Section apply to ALL work specified in this Division, unless modified to be of higher quality or more stringent in another Section.

1.2 INTENT

A. The CONTRACT DOCUMENTS are inclusive of all Drawings and Specifications, both those specifically covering the work of this Division and those covering other subjects of work.

B. It is the intent of the Contract Documents to require finished work, tested and ready for operation.

C. It is not intended that Contract Documents show every pipe, wire, conduit, fitting and appurtenance; however, such parts as may be necessary to complete the systems in accordance with best trade practice and Code requirements and to Engineer's satisfaction shall be deemed to be included.

D. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. DO NOT SCALE THE DRAWINGS.

1.3 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which would have been revealed by examination of site conditions and Contract Documents prior to executing Contract.

C. Where discrepancies occur within Contract Documents, notify Engineer, in writing, of discrepancy and request clarification. Until notified of Engineer's decision, include item or arrangement of better quality, greater quantity or higher cost in Contract price.

D. For material, device and equipment identified on Contract Drawings by manufacturer and/or model: Coordinate with Specification for ancillary requirements and include with furnished item.

E. Notify Engineer, in writing, of materials and apparatus believed to be omitted, inadequate or unsuitable, or in violation of laws, ordinances, rules or regulations of authorities having jurisdiction. In absence of such written notice, it is mutually agreed that bid price for work under each Section has included the cost of items required for acceptable satisfactory functioning of entire system.

1.4 DEFINITIONS

A. Where more than one material, item, or grade is listed in same paragraph, first one named is preferred choice.

B. The following terms are used in this Division and are defined as follows:

1. "Indicated", "shown", "noted", "scheduled", "specified": These terms are a cross-reference to graphics, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in Contract Documents. NO limitation of location is intended except as specifically noted.
2. "Directed", "requested", "authorized", "selected", "required", "permitted": Where not otherwise explained, these terms mean "directed by the Engineer", "requested by the Engineer", etc. However, NO such implied meaning will be interpreted to extend the Engineer's responsibility into Contractor's area of construction supervision or means and methods.
3. "Provide": To furnish and install, ready for safe and regular operation the item, material or service indicated.
4. "Furnish": To purchase, acquire and deliver to the site, complete with related accessories.
5. "Install": To erect, mount and connect completely, by acceptable methods.
6. "Work": Labor, materials, equipment, apparatus, controls and accessories required for proper and complete installation.
7. “Finished Spaces”: Spaces other than the following:

    a. Mechanical and electrical equipment rooms.
    b. Furred spaces.
    c. Pipe and duct shafts.
    d. Unheated spaces immediately below roof.
    e. Spaces above ceilings.
    f. Unexcavated spaces.
    g. Crawl spaces.
    h. Tunnels.

8. “Exposed”, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical or electrical equipment rooms.

9. “Exposed”, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
10. “Concealed”, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in shafts.
11. “Concealed”, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated structures.
12. "Acceptable equivalent" or "Equal": Of weight, size, design, capacity and efficiency to meet requirements specified and shown, and of acceptable manufacture, as determined in the opinion of the Engineer.
13. "Acceptable": Acceptable, as determined in the opinion of the Engineer.
14. "Contractor": General Contractor, Trade Contractor, sub-Contractor, or Construction Manager.
15. "Named" Product: Manufacturer's name for product, as recorded in published documents of latest issue as of date of Contract Documents. Obtain Engineer's permission before using products of later or earlier model.

1.5 STANDARDS

A. Standards, specifications and tests of following technical societies, organizations and governmental bodies, as referenced in Contract Documents, are hereby made part of Contract Documents.

1. ANSI: American National Standards Institute
2. ASTM: American Society for Testing and Materials
3. EPA: Environmental Protection Agency
4. FSSC: Federal Specification
5. IRI: Industrial Risk Insurers
6. ISO: Insurance Services Office
7. NBS: National Bureau of Standards
8. NEC: National Electrical Code.
9. NEMA: National Electrical Manufacturers Association
10. NFPA: National Fire Protection Association
11. NSC: National Safety Council
12. OSHA: Occupational Safety and Health Administration
13. UL: Underwriters Laboratories
14. AABC: Associated Air Balance Council
15. ACGIH: American Conference of Governmental Industrial Hygienists
16. ADC: Air Diffusion Council
17. AGA: American Gas Association
18. AMCA: Air Movement and Control Association
19. API: American Petroleum Institute
20. ARI: Air Conditioning and Refrigeration Institute
21. ASCE: American Society of Civil Engineers
22. ASE: Association of Safety Engineers
23. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers

24. ASME: American Society of Mechanical Engineers
25. ASPE: American Society of Plumbing Engineers
26. AWS: American Welding Society
27. AWWA: American Water Works Association
28. CGA: Compressed Gas Association
29. CSA: Canadian Standards Association
30. CISPI: Cast Iron Soil Pipe Institute
31. EJMA: Expansion Joint Manufacturing Association
32. FM: Factory Mutual Engineering Division
33. HIS: Hydraulic Institute Standards
34. IBR: Institute of Boiler and Radiator Manufacturers
35. MCAA: Mechanical Contractors Association of America
36. NEBB: National Environmental Balancing Bureau
37. NOFI: National Oil Fuel Institute
38. SBI: Steel Boiler Industry (Division of Hydronics Institute)
39. SMACNA: Sheet Metal and Air Conditioning Contractors National Association
40. STI: Steel Tank Institute
41. CODE: Codes and regulations of the Federal, State and local governments and of utility companies having jurisdiction, as appropriate.
42. CODE: Codes and regulations of the Federal, State and local governments and of utility companies having jurisdiction, as appropriate.

B. Use of singular or plural reference form in the Contract Documents shall not be construed to limit number of units required. Specifications are intended to define quality and performance characteristics; quantity of units supplied shall be as needed to meet requirements as specified and at a minimum, as shown on Contract Documents.

1.6 PERMITS, LAWS, ORDINANCES AND CODES

A. Contractor shall obtain and pay for permits, inspections, licenses and certificates required for work under this Division.

B. Complete Utility connections as indicated or needed, extension to Project, metering as required, and connection to building systems, including:

1. Apply for all services and pay for all fees, assessments and charges of the Utility for each connection, all in a timely manner and according to the Project Schedule.
2. Provide and install all metering equipment and accessories as required by Utility. Install entire service in accordance with the Utility's requirements or other applicable regulation.
3. Coordinate with Utility to determine scope of work provided by Utility and the part provided by Contractor so that a complete Utility connection is made.
4. Schedule all work required by utility companies in order to maintain project schedule.

C. Contractor shall pay utility company charges associated with work of this Division.

D. Contractor shall comply with laws, ordinances, rules and regulations of Local, State and Federal authorities having jurisdiction; and shall comply with rules and regulations of National Board of Fire Underwriters, National Electrical Code and local utility companies.

E. Contract Documents shall govern whenever they are more stringent than Code requirements.

1.7 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun, prepare coordination drawings showing relationship of work among all trades.

B. Submit completed and signed coordination drawings to the Engineer for review.

C. Coordination drawings are for use by Contractors and Engineer during construction and are not replacements for shop, as built, or record drawings required elsewhere in the Contract Documents

1.8 SHOP DRAWING SUBMITTALS

A. General

1. Prior to submission of specific shop drawings, submit for review a preliminary list of intended or proposed manufacturers for all items for which shop drawings are required.
2. Submit through contractual channels for review.
3. Number of copies as directed in DIVISION 1, but not less than 6.

B. Shop Drawings – Electronic: Identify and incorporate information in each submittal as follows:

1. Electronic Submittals: Submit in accordance with requirements of Project website submittals procedures.
2. Assemble complete submittal package into a single submittal, incorporating submittal requirements of a single Specification Section.
3. Metadata: Include the following information as keywords in the electronic submittal metadata:
    a. Project name.
    b. Number and title of appropriate Specification Section.
    c. Manufacturer name.
    d. Product name.
4. Shop drawings shall include the following information:

    a. Descriptive and product data necessary to verify compliance with Contract Documents.
    b. Manufacturer’s specifications including materials of construction, metal gauge, thickness, and finish.

c. Certified dimensional drawings including clearances required for maintenance or access.
d. Performance data, ratings, operating characteristics, and operating limits.
e. Operating points on curves.
f. Electrical ratings and characteristics.
g. Wiring and control diagrams, where applicable.
h. Certifications requested, including UL label or listing.
i. List of accessories which are required but are NOT being furnished by the product manufacturer or are NOT being provided by this Section. Identify the Section(s) by which the accessories are being furnished or provided.

5. Clearly mark submittals with the following:

a. Where equipment is specified, as follows:

1) Specifications: Section and paragraph.
2) Drawings: Drawing number, schedule, note, and detail, as required.

b. Equipment or fixture identification corresponding to that used in Contract Documents.
c. Accessories and special or non-standard features and materials, which are being provided.

6. The selection and intention to use a product specified by name shall NOT excuse the need for timely submission of shop drawings for that product.
7. For samples submitted in lieu of shop drawings, submit as follows:

a. Submit samples in duplicate.
b. Clearly identify the samples.
c. All samples that are not accepted will be returned.
d. For samples that are approved, one sample will be returned and one sample will be kept by the Engineer.

8. Upon completion of shop drawing review, shop drawings will be returned, marked with one of the following notations: Furnish as Submitted, Furnish as Corrected, Revise and Resubmit, Rejected, or Submit Specified Item. Use only products whose shop drawings are marked Furnish as Submitted or Furnish as Corrected.

C. Other Submittals

1. Refer to Sections of this Division for additional submittal requirements relating to specific equipment or systems.

D. Submission of shop drawings of an unnamed manufacture or shop drawings at variance with the Contract Documents is NOT a proper request for substitution.

E. Repeat submission of products without addressing all comments from prior review will be returned to the Contractor without review for correction. Note:

1. Contractor may be liable for additional efforts expended by the Engineer
2. Contractor WILL be liable for impact to project schedule.

F. Test reports are to be submitted to Engineer for review prior to acceptance of equipment or systems for beneficial use.

G. Options: Identify options requiring selection by Architect.

H. Deviations and Additional Information: Include relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

I. Resubmittals: Make resubmittals in same manner as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

K. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

L. Material Safety Data Sheets (MSDS):

1. If required by the Owner, submit MSDSs directly to the Owner; do not submit to Architect.
   a. Architect will not review submittals that include MSDSs and will return without review.
   b. Do not include MSDSs and remove MSDS sheets attached to product data or included with other submittals that require submission to the Architect.

1.9 PRODUCT SELECTION

A. Options for selecting products are limited by Contract Document requirements and governing regulations and are NOT controlled by industry traditions or procedures experienced by Contractor on previous construction projects. Required procedures include, but are NOT necessarily limited to, following specifying methods in Contract Documents:

1. Single Product Manufacturer Named: Provide product indicated.
2. Two or More Manufacturers' Products Named: Provide one of the named products, at Contractor's option, but excluding products which do NOT comply with requirements.
3. "Acceptable equivalent" or "Or Equal": Where named products are accompanied by this term or words of similar effect, provide one of named products or propose substitute product according to paragraph 1.10, SUBSTITUTIONS.
4. Standards, Codes and Regulations: Where specification requires only compliance with a standard, code or regulation, Contractor may select any product which complies with requirements of that standard, code or regulation.
5. Performance Requirements: Provide products which comply with specific performances indicated and which are recommended by manufacturer (in published product literature or by individual certification) for application intended. Overall performance of product is implied where product is specified with only certain specific performance requirements.
6. Prescriptive Requirements: Provide products which have been produced in accordance with prescriptive requirements using specified materials and components, and complying with specified requirements for fabricating, finishing, testing and other manufacturing processes.
7. Visual Matching: Where matching with an established material is required, Engineer's judgment of whether proposed product matches established material shall be final.
8. "Color as Selected by Architect": Unless otherwise noted, where specified product requirements include "color as selected by Architect" or words of similar effect, the selection of manufacturer and basic product complying with Contract Documents is Contractor's option and subsequent selection of color is Architect's option.

B. Inclusion by name, of more than one manufacturer or fabricator, does NOT necessarily imply acceptability of standard products of those named. All manufacturers, named or proposed, shall conform, with modification by manufacturer as necessary, to criteria established by Contract Documents for performance, efficiency, materials and special accessories.

1.10 SUBSTITUTIONS

A. Contractor's request for substitution may be submitted only after award of Contract. Requests shall be in writing and presented through appropriate contractual channels.

B. Substitution Request to include the following:

1. Detailed comparison of significant differences in quality, construction, performance, features, options, and appearance between specified item and proposed substitution. Citation, where applicable, to where a specified requirement is located in the Contract Documents is to be provided.
2. Statement of effect on construction time, coordination with other affected work, and cost of work.
3. Contractor's statement to the effect that proposed substitution will result in overall work equal to, or better than, work originally intended.

C. Substitution requests will be considered based on all of the following:

1. If extensive revisions to Contract Documents are NOT required.
2. If changes are in keeping with general intent of Contract Documents.
3. If submitted in timely and proper manner, fully documented.
4. If one or more of following conditions is satisfied; all as judged by Engineer:

    a. Where request is directly related to "acceptable equivalent" clause, "or equal" clause or words of similar effect in Contract Documents.
    b. Where specified product, material or method CANNOT be provided within Contract Time; but NOT as a result of Contractor's failure to pursue the work promptly or properly coordinate Contractor’s efforts.
    c. Where substantial advantage is offered Owner; in terms of cost, time, energy conservation or other valuable considerations; after deducting offsetting responsibilities that Owner may be required to bear, including additional compensation to Engineer for redesign and evaluation services, increased cost of other work by Owner or separate contractors, and similar considerations.

D. The burden is upon the Contractor, supplier and manufacturer to satisfy Engineer that:

1. Proposed substitute is equal to, or superior to, the item specified.
2. Intent of the Contract Documents, including required performance, capacity, efficiency, quality, durability, safety, function, appearance, space clearances and delivery date, will be equaled or bettered.

E. Submission of shop drawings of unspecified manufacture or shop drawings at variance with the Contract Documents is NOT a proper request for substitution.

F. Changes in work of other trades, such as structural supports, which are required as a result of substitution and the associated costs for such changes shall be the complete responsibility of Contractor proposing substitution. Except as noted in subparagraph 1.10.C.4 (a) above, there shall be NO additional expense to the Owner.

G. Substitution requests that require the Engineer to expend additional efforts for review, investigation, verification, or similar activities, will require the Contractor to compensate the Engineer at the rate of $120/hour if:

1. Engineer is not familiar with the proposed manufacturer or the proposed product from that manufacturer.
2. Engineer needs to investigate proposed product, attend presentations, confer with other professionals, contact references, or similar activities that would not otherwise have been required if one of the named products was proposed.
3. Engineer must travel to the manufacturer’s facilities or a representative installation of the proposed product to review, confirm, or assess product characteristics or directly communicate with manufacturer’s representatives on technical or product support subjects.

1.11 SAMPLES

A. Submit samples where required or referenced elsewhere in this Division of work.

B. Where in the opinion of the Engineer, a sample is required to clarify the acceptable characteristics of a material or product, additional samples may be required.

1.12 RECORD DRAWINGS

A. Furnish and keep on the job at all times, a minimum of one complete and separate set of Contract Documents for the purpose of tracking installation of the work.

B. As work progresses, record changes, revisions and additions to the work clearly, neatly, accurately and promptly. Items to be indicated include but are not limited to:

1. Dimensional change of equipment or material
2. Revision to Drawing Detail
3. Location and depth of underground utilities, structures, equipment, tanks, etc - referenced from project benchmarks
4. Location and depth of underslab utilities and distribution
5. Actual routing of distribution systems
6. Revision to power or control wire circuiting/source
7. Actual equipment location
8. Location of concealed distribution work such a pipes, conduits, ducts, etc
9. Location of concealed work and access panels, where access for maintenance or service is required.
10. Changes made by Change Order
11. Details not on original Contract Drawing, but used for installation of the work.
12. Information on concealed elements which would be difficult to identify or measure later.
13. Valve locations and numbers reflecting the final valve tag charts.

C. Indicate daily progress on these prints by coloring in the various lines, fixtures, apparatus and associated appurtenances as they are erected.

D. Approval of requisition for payment for work installed will NOT be given unless supported by record prints as required above.

E. At the conclusion of work, prepare final record drawings reflecting all field recorded data, neatly transferred from documents used in the field to a clean paper set of the Original Contract Documents. Submit record drawings for review by Engineer. After review and acceptance, the Contractor will be furnished with an electronic set of the original contract documents to be edited to reflect modifications and field data as reported on record drawings. Electronic copy of final “as-built” contract documents to be provided to the Owner in a format agreed upon at the commencement of work.

F. Coordination Drawings are to be updated, reflecting installation of work that differs from that presented on the Coordination Drawings which were signed off at the start of work. All trades will review and sign off on these documents as accurate. Electronic copy of final “as-built”

coordination drawings to be provided to the Owner in a format agreed upon at the commencement of work.

G. Refer to DIVISION 1, GENERAL CONDITIONS and SUPPLEMENTARY CONDITIONS for further requirements.

1.13 OPERATING AND MAINTENANCE MANUALS

A. Submit for review, at least two (or greater quantity if otherwise specified in Division 1), operating and maintenance (O&M) manuals for each system or piece of equipment. Applicable content, as generated, is to be collected continuously during the construction process and maintained in a DRAFT manual format for review by the Engineer at any time.

B. Completed manual will be reviewed by the Engineer and modifications made as identified, before distribution or use. Acceptance will be required prior to scheduling of Owner Training and Instructions.

C. Required modifications identified during Training and Instruction activities are to be made before final Manual is delivered to the Owner.

D. Refer to DIVISION 1 for additional requirements and procedures relating to O&M manuals.

E. Operating and maintenance manual(s) will be organized with the following fundamental content:

1. Table of Contents and Index

2. Project Information

   a. Contractor name, address, contact information, and primary contact individual specific to this project
   b. Sub-contractor names, responsibility, address, contact information, and primary contact individual specific to this project.
   c. Summary description of project scope and period of time work was executed.

3. Guarantees and Warrantees

   a. Documentation describing covered work/materials, effective coverage dates, and terms/conditions
   b. Contact information for initiating a claim and responsible party

4. Each Major Building System

   a. Supplier information including

      1) Technical Support contact

2) Source of parts / replacement units
3) Chain of purchase (Supply house, manufacturer's sales vendor, sub-contractor, etc), including Original order number/identification for tracking purposes

b. Operating Instructions

1) Prepared specific for this project

a) System Description
b) Operating parameters
c) Adjustable settings and purpose
d) Warnings and cautions
e) Sequence of Operations and Control Diagrams

2) Description of training and instruction provided to Owner including:

a) Date(s) of instruction/training
b) Agenda
c) Attendee list

c. Maintenance Instructions

1) Prepared specific for this project

a) Preventative maintenance schedule
b) Summary of consumable materials / regularly replaced elements
c) Recommended stocking materials and specialized tools or equipment necessary to perform regular and preventative maintenance
d) Maintenance contracts secured under this project, or separately contracted for through this provider.

d. Commissioning and Test Reports

1) Documentation of all inspection and testing activities performed with associated reports and corrective measures undertaken (if applicable).
2) Factory test reports
3) Certification letters for equipment manufacturers attesting to the complete and satisfactory installation and operation of systems/products.
4) Seismic inspection and certification
5) Special inspections
6) Sign off by Authorities Having Jurisdiction
7) Air and water balance report.

e. Parts / Material List

1) Bill of materials for each system or piece of equipment

f. Product Literature

1) Copy of shop drawings reflecting final acceptance by Engineer, with modifications made reflecting changes to the installed work which is not represented accurately.

g. Manufacturer's Operation & Maintenance Literature

1) Materials provided with equipment/products shipped for use on project
2) Supplementary materials which are required to provide the Owner with a complete representation of manufacturer's instructions and recommendations.

F. In addition to the above, the following Content is to be included in the Operation & Maintenance Manual(s):

1. BMS and temperature control shop drawings.
2. HVAC testing and balancing reports.
3. Commissioning and testing reports.
4. Other data, as required under pertinent Sections of these Specifications.

1.14 GUARANTEE

A. Furnish standard manufacturers' guarantees for work under this Division. Such guarantees shall be in addition to, and NOT in lieu of, other liabilities under the law or by other provisions of the Contract Documents.

B. Materials, equipment and workmanship shall carry the standard warranty against defects in material and workmanship. Failure which may develop due to defective or improper material, equipment, workmanship or design shall be made good, forthwith, by and at the expense of the Contractor, including damage done to areas, materials and other systems resulting from this failure.

C. Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth in Contract Documents.

D. Upon receipt of notice from Owner of a failure of system(s) or component(s) during the guarantee period, replace affected components within reasonable time period at no additional cost.

E. Guarantee period shall extend for one year from Date of Substantial Completion.

F. Before final request for payment, furnish written guarantee covering above requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Products shall be undamaged and unused at time of installation and shall be complete with accessories, trim, finish, safety guards and other devices and details needed for complete installation and for intended use.

B. Where available, products shall be standard products of types which have been produced and used previously and successfully on other projects and in similar applications.

C. Labels and Stamps

1. Locate labels and stamps required to be observed after installation on accessible surfaces. In occupied spaces, select locations that are not conspicuous.
2. Locate labels and stamps not required to be observed after installation on concealed surfaces.

D. Provide corrosion resistant fasteners of galvanized or stainless construction where exposed to moist corrosive conditions. Including but not limited to tunnels, manholes, greenhouses and exterior to the building.

PART 3 - EXECUTION

3.1 ARRANGEMENT OF WORK

A. Consult Architectural Contract Drawings and Details for exact locations of fixtures and equipment. If exact location is not given, obtain information from Engineer. Verify measurements in field. Base measurements on Engineer's established benchmarks.

B. Install work as closely as possible to layouts shown on Contract Drawings. Modify work as necessary to:

1. Provide maximum possible headroom and space clearance on each side.
2. Provide adequate clearance and ready access to all parts of the work, for inspection, operation, safe maintenance and repair, and code conformance.
3. Coordinate and arrange work to avoid conflicts with work of other trades, to avoid unnecessary cutting and patching, and as needed for satisfactory space conditions shown on coordination drawing submittals.
4. Where space appears inadequate, consult Engineer before proceeding with installation.

C. Coordinate installation of required supporting devices.

D. Set sleeves in cast-in-place concrete for services that will need to pass through concrete. Coring of installed concrete is not intended and the Contractor will be responsible for determining the impact on structural integrity, certifying that there will be no impact, and any remedial work required to accommodate impact from coring.

E. Work shall present a neat coordinated appearance.

3.2 COORDINATION

A. Examine Contract Documents and coordinate with Contractor and other trades as necessary to facilitate the progress of the work.

B. Each trade shall keep Contractor and other trades fully informed as to shape, size, and locations of openings, chases, equipment, panels, access doors, sleeves, inserts and anchor bolts required; whether temporary or permanent. Coordinate sizes, depths, fill and bedding requirements with excavation trades. Give sufficient advance notice so that coordination may be completed in advance. If information is not furnished in proper and timely fashion, the trade involved shall do own cutting and patching or have same done by Contractor, without additional cost to Owner.

C. Coordinate size and location of concrete bases with DIVISION 3 and the following:

1. Floor Drains and underslab utilities
2. Dimensional requirements for embedded anchors as necessary for support, vibration isolation, and seismic restraint.
3. Access and walkway requirements
4. Work of other trades

D. Particular emphasis is placed on timely installation of major apparatus and furnishing of other trades and Contractor with relevant information.

E. Do NOT install a system until critical components of system and related systems have been coordinated and applicable shop drawings have been accepted.

3.3 WORKMANSHIP

A. Work covered under this Division shall be constructed and finished in every respect in a workmanlike and substantial manner.

B. Equipment and materials shall be new, of first quality, selected and arranged to fit properly into spaces indicated.

C. Obtain detailed information from manufacturer as to proper methods for installation and connections. This includes such tests as equipment manufacturer recommends. Where documentation regarding installation is NOT obtainable, work shall be installed in accordance with best trade practice.

1. Unless specifically indicated otherwise on Contract Documents, equipment and materials shall be installed in accordance with manufacturer's recommendations.
2. Notify Engineer of conflicts between manufacturer's recommendations and Contract Documents requirements, and request clarification before proceeding with installation.

D. Where equipment, piping, ductwork, conduit, etc. is exposed, color of finish or paint shall be as selected by Engineer.

3.4 OPERATION OF SERVICES AND UTILITIES

A. During the construction period and until finally inspected, tested and accepted, maintain new services and utilities.

B. Shutdown of existing services and utilities shall, without exception, be coordinated with the proper utility and with the Owner as to date, time of day, and duration.

1. Notify Engineer and Owner of estimated duration of shutdown period at least ten days in advance of date when shutdown is proposed. Approval of shutdown shall be obtained from proper utility and Owner, before any service is interrupted.
2. Work during shutdown period shall be arranged for continuous performance, including overtime if required, to ensure that existing operating services will be shut down only for time actually necessary to complete connections.

3.5 PROTECTION

A. Contractor shall be responsible for work and equipment until fully inspected, tested and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material or damaging water.

B. Equipment shall be protected against damage while in storage either on or off the construction site. The equipment shall be stored in a dry environment with temperature and controlled to within ranges specified by the manufacturer. Space heaters shall be installed and energized when required to control humidity. Store light sensitive materials where not subjected to direct sunlight.

C. Protect work and material of other trades from damage that might be caused by work of this and other Divisions and correct damage thus caused.

D. Maintain protective measures used for transport of equipment or materials to project site until ready to set and connect utilities and related work. If protective covers need to be removed for inspection or coordination of work, repair or replace to equivalent.

3.6 IDENTIFICATION

A. Distribution systems such as pipes, tubing, conduits, sheetmetal, insulation, etc shall have following information clearly printed on the material: manufacturer's name, material grade, gauge, thickness, type, and data to identify required methods of attachment; as applicable. Unmarked material shall NOT be used.

B. Permanent nameplates shall be provided on each piece of service-connected, power-operated, or distribution equipment, on easily accessible surface. Nameplate shall include product name, model number, serial number, capacity, speed, ratings, and similar essential operating data.

1. Manufacturer's nameplate, name, trademark and address shall be attached permanently to equipment and material furnished. Nameplate showing distributor or Contractor will NOT be permitted.
2. Unless otherwise specified or requested, letters and numbers shall be 1/2” high.
3. Attach nameplates with screws or rivets. Wherever covers of adjacent units are interchangeable, attach nameplates to wall or backboard rather than covers.

C. Unless specified elsewhere in this Section, labels shall be provided to indicate equipment according to designations used in Contract Documents. Label shall be plastic nameplate with letters and numbers 1-1/2” high. Furnish directory indicating number, location and use of each item. After finish painting is completed, apply identification label where it will be readily visible from normal operating position on floor.

3.7 LUBRICATION

A. Equipment shall be furnished and installed so that lubrication points are conveniently and readily accessible for maintenance. Make these provisions by whatever means is appropriate: extended fittings, access doors, equipment location, etc.

B. No equipment shall be operated for temporary service or for testing purposes without proper lubrication. Items requiring lubrication shall be left freshly and fully lubricated at time of substantial completion.

C. Prior to substantial completion, deliver to Owner, along with itemized list: one complete new set of special lubrication devices required for servicing, such as grease guns, fittings and adapters.

3.8 ATTACHMENT OF SUPPORTS TO BUILDING STRUCTURE

A. Equipment shall be securely attached to building structure in acceptable manner. Attachments shall be of strong and durable nature as determined by Engineer.

B. Attachment of supports to roof decking is NOT permitted. Pipes, ducts, conduits, boxes, etc. must be supported from building structural framing (bar joist, beams, columns) or by supplementary members installed by the Contractor, spanning structural framing in a method acceptable to the structural engineer.

C. Cut, Fit and place miscellaneous metal supports for installation of work.

D. Field Welding: Comply with AWS D1.1 or other applicable standards

E. Refer to DIVISION 5 for material specification of supplemental members to be installed.

3.9 ACCESSIBILITY, ACCESS PANELS AND ACCESS DOORS

A. Locate equipment which must be serviced, including motor starters, switches, panels and junction boxes, in accessible locations if at all possible. For other locations, furnish access panels as described under DIVISION 1.

B. Access doors shall be located to conveniently serve intended purpose and shall be installed so that adjacent piping, equipment and structures do NOT render doors unusable.

C. Access doors are not required in removable panel ceilings if suitable identifying markers are provided to indicate access locations.

D. During project closeout, Contractor shall perform walk-through identifying and demonstrating access to equipment for service and/or replacement. Walk-through shall be arranged at times convenient for Engineer and Owner to attend.

1. Equipment with insufficient access shall be relocated or provided with additional access panels at no additional cost to Owner.
2. Trade responsible for access problem shall be responsible for costs of access modifications. In general, this shall be understood to be the trade installing the equipment. If access problem was caused by architectural layout changes which occurred

subsequent to equipment installation, cost of access modifications shall be borne by trade responsible for architectural changes.

3.10 WATERPROOFING

A. Where work pierces waterproofing, including waterproof concrete and floor of a wet area, submit method of installation for review by the Engineer before work is done.

B. Provide necessary sleeves, caulking and flashing required to make openings waterproof. See DIVISION 7 on WATERPROOFING.

3.11 GROUTING

A. Mix and install grout for equipment base bearing surfaces, base plates, and anchors

3.12 BASES AND SUPPORTS

A. Unless noted otherwise, provide necessary supports, rails, framing, bases and piers required for equipment furnished or installed under this Division.

B. Unless otherwise indicated: floor-mounted equipment shall be mounted on concrete pads. Concrete and associated reinforcing materials shall be as specified in DIVISION 3, CONCRETE.

1. Pads shall be three-inch thick minimum. Pads for seismically supported equipment shall extend at least 6 inches beyond equipment footprint. Coordinate final extension requirements with approved seismic shop drawing calculations and details. All other pads shall NOT extend more than one inch beyond equipment footprint. Top edge of pads shall be chamfered.
2. Furnish dimensional and load information so that shop drawings for pads may be submitted and reviewed prior to pad installation.
3. Equipment shall be firmly grouted into concrete pads and anchor bolted.

C. Where mounted on the floor: Foundations, supports, pads, bases and piers shall be of the same finish quality as the adjacent flooring material.

D. Equipment supports shall be designed and constructed so that equipment will be capable of resisting both vertical and horizontal movement. Refer to Section “VIBRATION AND SEISMIC CONTROLS” in this Division.

3.13 PAINTING

A. Unless otherwise specified, materials furnished under this Division shall have prime coat and standard manufacturer's finish.

B. Finish painting of exposed work and equipment is covered under DIVISION 9.

C. Paint equipment and appurtenances in concealed and unfinished areas with one coat of rust-inhibiting paint or with an appropriate bitumastic protective product designed for the intended application. Asphalt paint is NOT acceptable. Items to be painted shall include, but not be limited to: non-insulated hangers, supports, piping, conduit, tanks and other ferrous metal work, which are concealed or inaccessible but not galvanized.

D. Special care shall be taken to avoid painting or spattering equipment nameplates.

E. Cooperate in identifying systems for painters. Refer to paragraph, IDENTIFICATION.

3.14 TESTS - GENERAL

A. Make final adjustments to equipment before testing. Manufacturer's authorized representative shall verify proper installation and adjustment prior to startup of major equipment; refer to paragraph, OPERATING AND MAINTENANCE MANUALS.

B. Furnish labor, materials, instruments, supplies and services necessary for testing required under this Division. Correct defects appearing during tests, and repeat tests until no defects are disclosed. Final tests shall be made in Engineer's presence.

C. Use true RMS ammeter to measure current, for equipment which may have harmonic (non-linear) load component.

D. Notify Owner, Architect and Engineer of testing schedule at least 48 hours in advance of tests.

E. Perform specified tests and tests required by legal authorities and by agencies having jurisdiction over this Work. Tests shall be performed to the satisfaction of legal authorities, agencies having jurisdiction, and Owner.

F. Each piece of equipment, including motors and controls, shall be operated continuously for minimum test period of one hour.

G. If manufacturer's startup services are specified under other Sections in this Division, furnish services of factory-trained service engineering representative to provide following. If manufacturer's startup services are not required, Contractor shall furnish following services.

1. Inspection of equipment/system installation.
2. Assistance in initial startup and adjustment of equipment; including necessary time to achieve proper installation and adjustments.

3. Instruction of Owner's staff; see paragraph, INSTRUCTIONS.

H. Upon completion of tests, demonstrate the following:

1. Equipment and systems are installed and operating in accordance with manufacturer's specifications and instructions and with Contract Documents.
2. Proper adjustment of equipment and systems.
3. Systems are properly cleaned and free of contaminants.
4. Systems are properly phase balanced.
5. Circuits and motorized equipment are equipped with proper overload protection and are not operating under overload.
6. Instruments are recording properly.

I. Refer to testing requirements in other Sections of this Division for addition work.

3.15 INSTRUCTIONS

A. Arrange for each installer of work requiring continuing maintenance or operation, to meet with Owner's personnel at project site and instruct them in the operation and maintenance. Include instruction by manufacturer's representatives where installers are not expert in the required procedures. Instruction periods for all trades shall be minimum of 8 hours total; refer to individual SECTIONS for further requirements.

B. Instructions include, but are not limited to, the following:

1. Review of Operation and Maintenance manuals, record documentation, tools, spare parts and materials, lubricants, fuels, identification system, control sequences, hazards, cleaning, and similar procedures and facilities.
2. Demonstration of the following:

a. Start up procedures
b. Shutdown procedures
c. Emergency operations
d. Noise/vibration control adjustments
e. Safety concerns and protective equipment
f. Economy/efficiency adjustments
g. Cleaning
h. Similar operations

3. Review of applicable guarantees and warranties.
4. Demonstration of procedures for routine maintenance, at the equipment involved, to ensure proper accessibility to components involved.

3.16 QUIET OPERATION

A. Equipment and material provided as part of the Work shall NOT produce sound level greater than 55 decibels (or level required by Code, if more stringent) in adjacent occupied areas. Sound level shall be as measured on A-weighting scale of sound level meter or sound survey meter.

B. Methods described in ASHRAE guide and data books may be used to determine sound level of equipment when total of background sound and equipment sound exceeds the required minimum.

C. Contractor shall ensure that equipment and materials provided as part of the Work do NOT produce excessive noise/vibration and do NOT transmit excessive noise/vibration to occupied spaces. If objectionable noise/vibration occurs, Contractor shall provide systems, devices, and equipment necessary to eliminate objectionable noise/vibration at no additional cost to Owner.

D. Refer to VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL SYSTEMS for further requirements.

3.17 FINAL CLEANING

A. Clean each surface of each unit of work, to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with manufacturer's instructions for cleaning operations. The following are examples, but not limitations, of cleaning required:

1. Remove labels which are not required as permanent labels.
2. Clean transparent materials, removing substances which are noticeable as vision-obscuring.
3. Clean exposed hard-surfaced finishes, until free of dust, stains, films and similar noticeable substances.
4. Wipe surfaces of mechanical and electrical equipment clean, remove excess lubrication and other substances.
5. Remove debris and surface dust from limited-access spaces such as plenums, shafts, and ceiling spaces.
6. Clean lighting fixtures and lamps; removing dust, smudge marks and protective wraps; so as to function with full efficiency.

3.18 DEMOLITION, RENOVATION, IMPACT TO EXISTING

A. Demolition:

1. In areas where demolition of systems of this Division are indicated, the following requirements apply:

a. Disconnect and remove from the project site, and dispose of in a legal manner, all materials not otherwise identified to be handled otherwise.
b. Investigate impact to areas outside the designated area for demolition and identify any impact that demolition may have on those areas.
c. Building structure, partitions, floors, and walls to remain shall not be impacted by demolition work.

B. Selective Demolition

1. Major changes to existing building spaces and systems have been shown on Contract Drawings; minor changes have NOT been shown. Contractor shall anticipate that there will be numerous minor changes including:

   a. Removal and/or relocation of pipes, conduits, wiring, etc
   b. Removal and/or relocation of wall and ceiling mounted devices due to architectural revisions or phasing
   c. Temporary relocation of existing devices or distribution equipment to permit installation of new work.
   d. Temporary work and modifications to existing systems to maintain Owner’s use and operations in areas outside the boundaries of the work.
   e. Work related to phased demolition of existing systems
   f. Work related to phased installation of new work

2. Remove, store, clean and relocate equipment designated to be relocated and reused.
3. Material which is removed and is not designated for reuse shall, at the Owner's option, either:

   a. Be delivered to Owner's storage location
      OR
   b. Become Contractor's property and be removed from the site and disposed of properly

END OF SECTION 230500

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SECTION 230510 – PROJECT COORDINATION AND COORDINATION DRAWINGS

SECTION 230510 - PROJECT COORDINATION AND COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 REFERENCES

A. Refer to the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and applicable parts of DIVISION 1 for other general requirements.

B. GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and DIVISION 1 paragraphs may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall NOT be construed to reduce the requirements of those Divisions NOR to eliminate other requirements under those Divisions.

C. Refer to other Sections of this Division for detailed specifications on the work of this Division.

D. THIS PROJECT WILL BE COMMISSIONED. REFER TO COMMISSIONING SPECIFICATION SECTIONS FOR COMMISSIONING INFORMATION AND RESPONSIBILITIES. THE COMMISSIONING PROCESS WILL REQUIRE ADDITIONAL LABOR, MATERIAL AND/OR OTHER COSTS WHICH MUST BE PROVIDED BY THE INDIVIDUAL TRADE CONTRACTORS AS PART OF THIS PROJECT.

1.2 INTENT

A. The Contract Documents define a complete installation, comprised of many individual components, assemblies and systems. It is the intent of these documents that the work of all trade contractors, sub-contractors, and all sub-contracted entities performing the work be coordinated to result in finished project, meeting the performance requirements of these documents.

B. The use of the terms “contractor”, “trade contractor”, or “sub-contractor” in this Section is to be interpreted as referring to all trades, singularly and collectively.

C. Definition of roles and responsibilities as pertains to the scope of this section:

1. Contractor:

a. Management, Schedule, and Execution of project coordination and coordination drawing process.
b. Translation of Design Intent and Project requirements, presented within the Contract Documents, into coordinated layout and fabrication drawings.
c. All reasonable efforts to resolve apparent conflicts in the work, identified in the coordination process, without impact to Design Intent and Project Requirements.

2. Architect/Engineer:

    a. Interpretation of Contract Documents
    b. Prioritization of Project Requirements where necessary to resolve multiple requirements determined as in conflict after Contractor's coordination activities are exhausted.
    c. Review and assistance with resolution of apparent conflicts identified by Contractor, provided that reasonable efforts by Contractor have been undertaken to first resolve apparent conflict.
    d. Accept or Reject Contractor's proposed adjustments to the work.

1.3 RELATED SECTIONS

A. Refer to the following related sections:

1. DIVISION 1 – Section(s) related to Phasing, Construction Schedule, Procedures, and Coordination of the work.
2. DIVISION 21 – Section related to "Project Coordination and Coordination Drawings"
3. DIVISION 22 – Section related to "Project Coordination and Coordination Drawings"
4. DIVISION 23 – Section related to "Project Coordination and Coordination Drawings"
5. DIVISION 26 - Section related to "Project Coordination and Coordination Drawings"
6. DIVISION 27 – Section related to "Project Coordination and Coordination Drawings"
7. DIVISION 28 – Section related to "Project Coordination and Coordination Drawings"

1.4 SEQUENCE OF WORK

A. Before commencement of project coordination and before procurement of materials, Contractor and all sub-Contractors, shall familiarize themselves with the work and requirements of all trades.

B. Phased Sequence of Work:

1. If provided, review phasing plans and requirements set forth in the Contract Documents and any Supplementary information provided.
2. Contractor is responsible for generating a complete phasing plan for the project.
3. Identify work that requires careful scheduling in coordination with proposed phasing in order to meet project requirements for completion dates, and operation of systems.
4. Obtain clarifications from Owner and Architect/Engineer on requirements or conditions that directly affect scope work within specific phases of work.
5. Make adjustments to phasing plan and scope or work per phase after review and acceptance by Owner and Architect/Engineer.

C. Project Schedule(s):

1. Review schedules published in the Contract Documents and any supplementary information provided.
2. Coordinate sufficient time allocations in the Contractor's schedule for Shop Drawing submission and review, Procurement of materials, and the coordination process.
3. Identify elements that will establish the critical path to project completion at the designed date. Adjust schedule of work to accommodate the proper sequence of work as outlined herein.
4. Coordinate equipment arrival and rigging access to interface with overall project sequence. Coordinate and plan with manufacturer for any equipment "splits" required to set equipment in final location. If field breakdown is required, directions shall be provided in writing from the manufacturer for procedures to be followed. Any field breakdown and reassembly is to be inspected by equipment manufacturer before final connections are made. Ensure an adequate pathway is available, such as corridors and openings, to transport equipment.

D. Investigation and Collection of Relevant Information:

1. Review all Contract Documents and referenced standards.
2. Review all Owner requirements.
3. Investigate field conditions as it relates to installation and coordination of work.
4. Identify areas where investigation requiring partial deconstruction of existing or newly constructed work is required to fully inform the Contractor on conditions that are critical to coordination of the work.
5. Perform investigations in coordination with the work of other trades and/or owner's use of existing areas.

E. Equipment Shop Drawings:

1. Shop drawings for major equipment and equipment with service connections, should be submitted and accepted prior to coordination drawing efforts in areas adjacent to equipment placement. Information on utility connections, weight and dimensions, access, working clearances, rigging methods, etc are to be represented on the Coordination Drawings for the specific equipment being installed.

F. Preparation of Coordination Drawings:

1. Coordination Drawings are to be prepared as a collaborative effort between all trade Contractors working on the project.
2. The following information, as a minimum, is to be represented on the Coordination Drawing – Floor Plans:

    a. Accurately scaled to no smaller than 1/4" = 1'-0". Where areas are congested and smaller scale is insufficient to clearly detail aspects of the work, Contractor to provide documents at larger scale.
    b. Floor plan layout of walls, doors, windows, equipment pads, etc.
    c. Building structure, dimensionally accurate with depth and elevation.

d. Ceiling systems, including reference to height and type of ceiling. Locate coordinated position of access doors where required to gain access to work. Soffits and other ceiling contours represented.
e. Indicate by shadow or similar means, required access points for service to above ceiling components such as valves, clean-outs, strainers, fire dampers, VAV boxes, FCU's, pull boxes, control panels, etc.
f. HVAC trade work:

1) Ductwork
2) Piping, including expansion loops
3) Elevation of ductwork and piping including allowances for insulation thickness indicated
4) Equipment – base/floor mounted
5) Equipment – suspended
6) Valves on distribution systems
7) Control Panels
8) Working clearances

g. Plumbing Trade Work:

1) Sanitary, storm, and vent piping
2) Water piping mains
3) Valves on distribution systems
4) Equipment – base/floor mounted
5) Equipment – Suspended
6) Specialty system distribution
7) Control panels
8) Working clearances

h. Fire Protection Work:

1) Risers, mains, and branch piping
2) Heads
3) Hose/valve cabinets
4) Valves on distribution systems
5) Detectors for special extinguishing systems
6) Service equipment
7) Fire pump and trim
8) Panels / Control Panels
9) Working Clearances

i. Electrical Trade Work:

1) Electrical distribution equipment
2) Conduit runs for major feeders (panels and major equipment)
3) Branch circuit wiring collection boxes

4) Main telecommunications conduits, racks, and/or open cabling space allowance
5) Pull boxes for major feeders and telecom conduits
6) Cable tray
7) Lighting
8) Ceiling mounted devices such as speakers, detectors, sensors, etc
9) Control panels
10) Working clearances both at floor level access and overhead access
11) Duct smoke detectors, indicated on duct layouts

3. All trades contributing to the development of the Coordination Drawings are to sign off on the final completed documents, including the General Contractor (if applicable) and/or Construction Manager (if applicable).

G. Equipment Placement:

1. No equipment is to be placed before all connections and provisions have been verified and coordinated.
2. Working space and clearances for service are to be maintained and verified prior to placement of equipment support provisions such as pads, frames, supports, dunnage, curbs, or anchors.

H. Installation of Work:

1. Work is to be installed in conformance with coordination drawings that have been signed off and accepted.
2. Work installed prior to completion of the Coordination Process will be subject to removal at the Contractor's expense.

I. Changes made in the field:

1. The Coordination Drawings are to be periodically updated during the project to reflect changes to the work which are made by Change Order or adjustments for other cause.
2. Changes that result in coordination conflicts are to be resolved immediately before related work continues.

1.5 RENOVATIONS & EXISTING CONDITIONS (Where Applicable)

A. The Contract Documents do not necessarily show all existing conditions, all new work to existing work interfaces, nor the complete extent of patching, repair, and renovation.

B. Unless otherwise noted, work shall be planned and executed assuming that areas not scheduled at that time to be renovated are intended to be in use and occupied. Existing services must be maintained that serve occupied areas of the building(s) or site.

C. Thoroughly study, examine, and investigate existing field conditions including, but not limited to, conditions in areas of limited accessibility such as crawl spaces, plenums, attics, chases, and above ceilings.

D. Plan and execute investigative work, including selective demolition, of concealed spaces where new work is scheduled to be installed.

E. Coordinate investigative efforts so that the disruption of Owner's operations is not affected. Work after Owner's normal hours of operation may be required and is to be provided.

F. Interruption of building services to be scheduled to minimize impact to the Owner's operations. Interruptions may only be made after timely notification to Owner and any involved utilities. Advance notification requirements are to be investigated and incorporated into project schedule(s) to avoid impact to the orderly installation of the work. Overtime or after hours work may be required and is part of Contractor's responsibility.

1.6 AVAILABILITY OF ELECTRONIC FILES

A. Electronic files (CAD) of the project floor or site plans may be available from the project Architect (or Engineer). Refer to other Sections and Instructions of the Contract Documents to confirm if these will be made available. Unless otherwise stated, assume that electronic files will not be made available.

B. Electronic files (CAD) of the project's Mechanical and Electrical Contract Documents will not be made available unless otherwise stated.

C. Electronic Files for BIM Projects (where applicable). BIM Model content related to the Mechanical and Electrical systems will not be released for the purposes of coordination by the contractor.

1.7 SUBMITTALS

A. Submittal of Coordination Drawings to be made with sufficient time planned for review and revision. The potential for additional steps of coordination prior to the scheduled commencement of work should be anticipated.

B. Separately developed Coordination Drawings may be required for elements of the work. Refer to requirements outlined later in this Section.

C. Refer to other Sections and Divisions of these Specifications for other related Submittal requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. No specific materials are specified in this section. Refer to other sections of this Division and other Divisions of the Specifications for material specifications.

PART 3 - EXECUTION

3.1 TRADE SPECIFIC LAYOUT AND FABRICATION DRAWINGS

A. Trade or system specific layout drawings may be required in other Section of this and other Divisions. Content that is common between these layout drawings and requirements for the Coordination Drawings shall be coordinated and developed in parallel where practical.

3.2 SITE WORK AND UTILITIES

A. Coordination Drawing prepared reflecting:

1. Underground site utilities, size and invert
2. Site Structures for Utility Distribution, size, placement, invert
3. Include concrete encasement dimensions where applicable

3.3 BELOW SLAB LAYOUT DRAWINGS

A. Coordinated drawing which includes all below slab utilities and distribution. Indicate dimensions and invert of all services. Include the following as a minimum:

1. Sanitary, Storm and Vent Piping
2. Electrical Conduits
3. Sumps, Drains, and other equipment that extends below the floor plane
4. Structural footing
5. All other Mechanical or Electrical services below areas of slab on grade

3.4 COORDINATION DRAWINGS – DEMOLITION

A. For renovation projects that require selective demolition, prepare a separate coordination drawing based on existing conditions, indicating:

1. Points of cut/cap for existing systems to remain
2. Major equipment removals and associated services

3.5 COORDINATION DRAWINGS – NEW WORK

A. Coordination Drawings prepared as indicated in this Section.

3.6 RISERS, SHAFTS, AND CHASES

A. Provide sections of all risers that extend beyond two floor levels of the building.

3.7 SECTIONS AND ELEVATIONS

A. Minimum of 1 longitudinal and 1 cross section through every Mechanical Room and Major Electric Service and Distribution Room

B. Cross sections to be provided in areas on congestion where services are stacked in elevation.

END OF SECTION 230510

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SECTION 230517 – SLEEVES AND SLEEVE SEALS FOR HVAC PIPING AND DUCTWORK

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING AND DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Refer to Section, “COMMON WORK RESULTS FOR MECHANICAL”.

C. Refer to Division 07 Specification – “PENETRATION FIRE STOPPING”.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Sleeves: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Pipeline Seal and Insulator, Inc.
4. Proco Products, Inc.
5. Thunderline Link Seal.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: Interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

a. EPDM-Standard and Chemical Service -40°F to 250°F
b. Nitrile-Oil Resistant Service -40°F to 210°F
c. Silicone – High/Low Temperature Service -67° to 400°F

2. Pressure Plates: Carbon steel Plastic Stainless steel.

a. Plastic – Standard Service
b. Plastic –Oil Resistant Service
c. Steel – High/Low Temperature Service

3. Connecting Bolts and Nuts: Length required to secure pressure plates to sealing elements.

a. Stainless Steel – Standard Service
b. Stainless Steel – Oil Resistant Service
c. Steel With Corrosive Resistant Coating – High/Low Temperature Service

2.3 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.

B. Description: Manufactured, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 FIRE STOPPING SYSTEMS

A. Fire and or smoke stopping shall be provided where mechanical systems penetrate rated assemblies. It is intended that ratings and sealing requirements will be specified under architectural separate divisions of work. In the event that sealing methods or products are not specified elsewhere, the following shall be used as the basis for executing this work.

B. Use only firestop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

C. Subject to compliance with through penetration firestop systems listed in the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:

1. Hilti, Inc., Tulsa, Oklahoma
   800-879-8000
   www.us.hilti.com
2. Provide products from the above or other acceptable and equivalent manufacturer.

D. Foams, intumescent, sealants, or caulking materials for use with non-combustible items, and/or flexible cable or cable bundles, the following products are acceptable:

1. Hilti Intumescent Firestop Sealant
2. Hilti Fire Foam
3. Hilti Flexible Firestop Sealant
4. Hilti Elastomeric Firestop Sealant

E. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including PVC jacketed, flexible cable or cable bundles, and plastic pipe, the following products are acceptable:

1. Hilti Intumescent Firestop Sealant

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (2-inch when seismic) annular clear space between piping and concrete slabs and walls.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants." Where no barrier is specifically defined by the Architect, the contractor shall install loose fill of therma-fiber and caulk sealant for acoustic and pest/rodent mitigation

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

F. Provide curbed or sleeved water-stop at all floor duct penetrations including intermediate floors. Penetrations shall be sealed and caulked as required to prevent the vertical passage of water.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in all exterior walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C. Exterior below-grade installations shall utilize stainless steel bolts and plates.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Coordinate OD of sleeve with wall placement, and width dimensions, to ensure the sleeve does not impact wall finishes. This may require dimensional coordination drawings collaboratively developed by all trades.

C. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

D. Secure nailing flanges to concrete forms.

E. Using grout, seal the space around outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with link seals.
    b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with link seals.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 2-inch annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 2-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
    b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.

5. Interior Partitions:

    a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
    b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517

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SECTION 230519 – METERS AND GAGES FOR HVAC PIPING

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Thermowells.
5. Dial-type pressure gages.
6. Gage attachments.
7. Test plugs.

B. Related Sections:

1. Division 23 Section, “Instrumentation and Control for HVAC”.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Wiring Diagrams: For power, signal, and control wiring.

C. Product Certificates: For each type of meter and gage, from manufacturer.

D. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

E. Meters: Project specific data including measurement range, medium, and pipe size.

F. Provide final calibration report for flowmeters and thermal-energy meters.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler.
5. WIKA Instrument Corporation - USA.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

E. Connector Type: Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ashcroft Inc.
b. Trerice, H. O. Co.
c. Weiss Instruments, Inc.
d. Weksler.

e. WIKA Instrument Corporation - USA.

2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Connector Type(s): Union joint, bottom; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Trerice, H. O. Co.
    b. Weiss Instruments, Inc.
    c. Weksler.
    d. WIKA Instrument Corporation - USA

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.5 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Brass.
4. Material for Use with Steel Piping: Stainless steel.
5. Type: Stepped shank for systems operating at 100 PSI or less, tapered shank for systems operating over 100 PSI.
6. External Threads: NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: ASME B1.1 screw threads to match thermometer.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.6 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ashcroft Inc.
    b. Marsh Bellofram.
    c. Trerice, H. O. Co.
    d. Weiss Instruments, Inc.
    e. Weksler.
    f. WIKA Instrument Corporation - USA.

2. Standard: ASME B40.100.

3. Case: Liquid-filled or sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ashcroft Inc.
    b. Trerice, H. O. Co.
    c. Weiss Instruments, Inc.
    d. Weksler.
    e. WIKA Instrument Corporation - USA.

2. Standard: ASME B40.100.
3. Case: Sealed type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.7 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of steel pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.8 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Suitable for pressure, temperature and type of liquid in system.

G. Provide gauge test kit for Owner’s use.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter on pipe 3 inches and under and to center of pipe on pipe over 3 inches, and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids (except steam).

J. Install test plugs in piping tees, on top of pipe.

K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

L. Install flowmeter elements in accessible positions in piping systems.

M. Install differential-pressure-type flowmeter elements, with the required minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

N. Install permanent indicators on walls or brackets in accessible and readable positions.

O. Install connection fittings in accessible locations for attachment to portable indicators.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. For flanged meter installations, provide valved bypass to allow meter removal for servicing.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers in fuel oil piping locations shall be one of the following:

1. Sealed, bimetallic-actuated type.
2. Industrial-style, liquid-in-glass type.

B. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:

1. Sealed, bimetallic-actuated type.
2. Remote-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Contractor shall choose manufacturer’s standard ranges nearest the values below.

B. Scale Range for Fuel Oil Piping: Minus 40 to plus 160 deg F.

C. Scale Range for Air Ducts: 0 to 150 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Contractor shall choose manufacturer’s standard ranges nearest the values below.

B. Pressure gages at each pump shall be the following:

1. Liquid-filled, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Fuel oil pumps: 0 to 100 psi.

B. Scale Range for Fuel oil strainers: 30 in. Hg to 15 psi.

END OF SECTION 230519

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SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. The Professional Engineer shall be legally qualified to practice in jurisdiction where project is located, and shall be experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for design and installation of hangers and supplies.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

C. Refer to Section 230548 “Vibration and Seismic Controls for HVAC Piping and Equipment” for additional requirements.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified Professional Engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.
5. Seismic restraints.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cooper B-Line, Inc.
b. Flex-Strut Inc.
c. Thomas & Betts Corporation.
d. Unistrut Corporation; Tyco International, Ltd.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized.
8. Paint Coating: Epoxy.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International; a subsidiary of Mueller Water Products Inc.
b. Empire Industries, Inc.
c. ERICO International Corporation.
d. Haydon Corporation; H-Strut Division.
e. NIBCO INC.
f. PHD Manufacturing, Inc.
g. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
2. Piping Technology & Products, Inc.
3. Rilco Manufacturing Co., Inc.
4. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 galvanized, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
b. NPS 4: 12 inches long and 0.06 inch thick.
c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with hot dipped galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
8. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
9. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
10. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
11. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
12. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
13. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
14. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
15. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
16. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

17. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
18. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23) with retaining clips: For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39) for insulated piping without vapor barrier: To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections. Provide spring hangers and supports per Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

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SECTION 230548 – VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding and restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Restrained vibration isolation roof-curb rails.
12. Seismic snubbers.
13. Restraining braces and cables.
14. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC
2. Assigned Seismic Use Group or Building Category as Defined in the IBC

    a. Component Importance Factor: Per IBC.
    b. Component Response Modification Factor: Per IBC.
    c. Component Amplification Factor: Per IBC.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ESor OSHPD or an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Engineering stamp shall be of the state in which the project takes place.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring

deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic and Wind-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
    c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
    d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries Inc. or a comparable product by one of the following:

1. Vibro-Acoustics.
2. Vibration Mountings & Controls, Inc.

B. Pads Mason Industries Model Super W: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

C. Resilient Material: Oil- and water-resistant neoprene mounts Mason Industries Model ND: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts Mason Industries Model BRA RBA: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators Mason Industries Model SLF: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators Mason Industries Model SLR: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts Mason Industries Model SSLFH: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. Elastomeric Hangers Mason Industries Model HD: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers Mason Industries Model 30N: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
8. Spring and hanger box to be powder coated for indoor use.

J. Spring Hangers with Vertical-Limit Stop Mason Industries Model 30N with Seismic Rebound Washer: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.
9. Spring and hanger box to be powder coated for indoor use.

K. Pipe Riser Resilient Support Mason Industries Model ADA: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

L. Resilient Pipe Guides Mason Industries Model VSG: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries or a comparable product by one of the following:

1. Vibro-Acoustics.
2. Vibration Mountings & Controls, Inc.

B. Steel Base Mason Industries Model WF: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base Mason Industries Model BMK/KSL: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries or a comparable product by one of the following:

1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Hilti, Inc.

3. TOLCO Incorporated; a brand of NIBCO INC.
4. Unistrut; Tyco International, Ltd.
5. Vibro-Acoustics.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ESor OSHPD or an agency acceptable to authorities having jurisdiction

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least fourtimes the maximum seismic forces to which they will be subjected.

C. Snubbers: Mason Industries Model Z-101 and Z-1225. Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

D. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

E. Restraint Cable Assemblies: Mason Industries Model SCB/SCBH, ASTM A 603 galvanized, steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

F. Hanger Rod Stiffener: Mason Industries Model SRC, reinforcing steel angle clamped to hanger rod.

G. Bushings for Floor-Mounted Equipment Anchor Bolts: Mason Industries Model HG. Bridge bearing neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Mason Industries Model PB. Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

I. Resilient Isolation Washers and Bushings: Mason Industries Model HG. One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. Mechanical Anchor Bolts: Mason Industries Model SAB/SAS. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Mason Industries Model SAA. Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings for indoor use.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic and wind control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or OSHPD or an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or

drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Mason Industries Model V-Loop. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Selection of testing agency to be approved by owner.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.

7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Section 017900 "Demonstration and Training."

B. Engage the services of a qualified seismic engineer to inspect the final installation and write a stamped letter of compliance certifying that all required devices have been properly installed and adjusted.

3.8 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

PIPE SEISMIC RESTRAINT SCHEDULE				
Piping	**Pipe Size**	**Seismic Restraint Type**	**Maximum Spacing between Seismic Restraints**	
			Transverse	**Longitudinal**
Compressed air piping	1” & larger	SCB/SCBH	20’-0”	40’-0”
Fuel piping	1” & larger	SCB/SCBH	20’-0”	40’-0”
Other piping in mechanical rooms	1-1/4” & larger	SCB/SCBH	40’-0”	80’-0”

Other piping in any space	2-1/2" & larger	SCB/SCBH	40'-0"	80'-0"
Horizontal chimneys and stacks	Any size	SCB/SCBH	30'-0"	N/A
Vertical chimneys and stacks	Any size	SCB/SCBH		At every floor level

A. Vibration isolation shall be provided on piping within 50 feet of connection to isolated equipment. Isolation type, minimum deflection and maximum spacing of isolation devices shall be as follows:

PIPE VIBRATION ISOLATION SCHEDULE			
Piping	**Vibration Isolation Type**	**Minimum Deflection**	**Maximum Isolation Spacing**
Horizontal water piping within 50 feet or 100 diameters of rotating equipment	30N	1"	At every hanger
Vertical water piping within 50 feet or 100 diameters of rotating equipment	ADA	0.10"	At every hanger or floor
**Use deflection of associated equipment isolator, if greater*			

B. Seismic restraint shall be provided on ductwork at every turn, at duct ends, and throughout entire run; where ductwork is supported by hangers longer than 12", as measured from duct-hanger attachment point to bottom of supporting structure. Restraint type, minimum deflection, and maximum spacing of restraints shall be as follows:

Ductwork	**Seismic Restraint Type**	**Maximum Spacing between Seismic Restraints**	
		Transverse	**Longitudinal**
With cross-sectional area of 6 square feet or greater	SCB/SCBH	30'-0"	60'-0"
Round ducts with diameter of 28" or larger	SCB/SCBH	30'-0"	60'-0"
Duct risers	BRA/RHB	At each floor	N/A

C. Seismic restraint shall be provided on all rotating mechanical equipment. Vibration isolation shall be provided on mechanical equipment where indicated. Isolation and restraint device types and minimum deflection shall be as follows:

SUSPENDED EQUIPMENT SEISMIC RESTRAINT & VIBRATION ISOLATION SCHEDULE			
Suspended Equipment	**Isolator Type**	**Minimum Static Deflection**	**Seismic Restraint Type**
Generator exhaust silencer	30N	1”	SCB/SCBH
In-line pumps	HD	0.30”	SCB/SCBH
In-line exhaust fans	30N	1”	SCB/SCBH
Wall-mounted non-isolated equipment, if not specified elsewhere	NA	NA	SAB/SAS
Non-isolated equipment suspended from structure, if not specified elsewhere	NA	NA	SCB/SCBH
* Combination seismic restraint and isolator			

BASE-MOUNTED EQUIPMENT SEISMIC RESTRAINT & VIBRATION ISOLATION SCHEDULE			
Base-Mounted Equipment	**Isolator Type**	**Minimum Static Deflection**	**Seismic Restraint Type**
Generator remote radiator	BRA/RBA	0.30”	BRA/RBA
Circulating pumps	BRA/RBA	0.30”	BRA/RBA
Roof-mounted non-isolated equipment, if not specified elsewhere	N/A	N/A	SAB/HG
Floor-mounted non-isolated equipment, if not specified elsewhere	N/A	N/A	SAB/HG

- Combination seismic restraint and isolator

** Equipment mat require the use of an inertia base based on the type, horsepower and location within the facility.

D. Each floor-mounted pump over 10 HP shall be bolted and grouted to reinforced concrete inertia base. Support concrete base by isolators as specified.

E. For each pump under 10 HP, bases shall be securely bolted to concrete housekeeping pad and shall be grouted according to manufacturer's instructions. Grout shall be high quality, non-shrink type by Chem-Comp or acceptable equivalent.

END OF SECTION 230548

TABLE OF CONTENTS
SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.
7. Access identification.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White Background Color: Black.
3. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Design, and colors should comply with OSHA regulations and ANSI/ASME A13.1 (2007)

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch

E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

F. Fasteners: Stainless-steel self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size and label length to be in accordance with ASME/ANSI A13.1 (2007) requirements which are in the table below.

Outside Pipe Diameter Including Covering, inch	Minimum Length of Label Field Color, inch	Minimum Height of Letters, inch

0.75 – 1.25	8	0.5
1.5 - 2	8	0.75
2.5 - 6	12	1.25
8 -10	24	2.5
Over 10	32	3.5

3. Lettering: Use the following Legend:

FOR	Fuel oil return
FOS	Fuel oil supply

4. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers extending 360 degrees around pipe at each location.
5. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Colors: For air without any hazardous material, white letters on blue background. For air with toxic or corrosive content, black lettering on orange background.

C. Maximum Temperature: Able to withstand temperatures up to 160 deg F

D. Label and Lettering Size:: To be in accordance with the table below:

Duct Width or Height Including Cover, inch	**Minimum Length of Label Field Color, inch**	**Minimum Height of Letters, inch**
Up to 6	12	1.25
7 to 10	24	2.5
Over 10	32	3.5

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers. Minimum tag size 2”x2”

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches .
2. Fasteners: [Brass grommet and wire].
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

B. Color, Lettering, Design: To be in accordance with OSHA regulations and ANSI /ASME A13.1 (2007).

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: No color coding will be provided.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet and at least once in every room.

C. Pipe Label Color Schedule:

1. Fuel Oil Piping:

a. Background Color: Yellow.
b. Letter Color: Black.

D. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. For all ducts carrying air without hazardous content, white lettering on blue background.
2. ASME A13.1 (2007) Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Fuel Oil: 2 inches square.

2. Valve-Tag Color:

a. Fuel Oil: Yellow.

3. Letter Color:

a. Fuel Oil: Black.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 231111 - FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies requirements for a main oil storage tank, day tank(s), and fuel oil specialties.

B. This Section includes fuel-oil and diesel-fuel-oil distribution systems and the following:

1. Pipes, tubes, and fittings.
2. Piping and tubing joining materials.
3. Piping specialties.
4. Valves.
5. Fiberglass, fuel-oil USTs.
6. Fuel-oil UST accessories.
7. Fuel-oil storage tank piping specialties.
8. Leak-detection and monitoring system.

1.3 DEFINITIONS

A. UST: Underground storage tank.

1.4 DESIGN AND PERFORMANCE REQUIREMENTS

A. Delegated Design: Design restraint and anchors for fuel-oil piping, USTs, and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Refer to Section 230548 “Vibration and Seismic Controls for HVAC Piping and Equipment” for additional requirements.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, and dimensions of individual components and profiles. Also include, where applicable, rated capacities, operating characteristics, electrical characteristics, and provided specialties and accessories.

1. Piping specialties.
2. Valves: Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Each type and size of fuel-oil storage tank. Indicate dimensions, weights, loads, components, and location and size of each field connection.
4. Fuel-oil storage tank accessories.
5. Fuel-oil storage tank piping specialties.
6. Liquid-level gage system.
7. Leak-detection and monitoring system.
8. Day tanks including containment, leak detection, level controls and accessories

B. Electrical wiring diagrams for power supply, interlocks, and controls

C. Control system and components including controls and instrumentation wiring diagrams.

D. Detailed sequence of operation.

E. Shop Drawings: Contractor supplied shop drawings for facility fuel-oil piping layout coordinated with other services and utilities. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: as required.
2. For fuel-oil storage tanks and pumps, include details of supports and anchors.

F. Brazing certificates.

G. Welding certificates.

H. Field quality-control reports.

I. Record Documents:

1. As-built record drawing showing actual location of the pump set and other equipment provided under the scope of this Contract.
2. Written manufacturer’s warranty and guarantee in the name of the Owner.
3. Three (3) sets Operation and Maintenance (O&M) Manuals, including replacement and spare parts list, with specific part items highlighted or checked on the parts list. Manuals

shall include specific maintenance and lubrication procedures. Vendors to provide PDF format to contractor and engineer for review.

4. As-built wiring diagrams and schematics for inclusion within the pump set control panel.
5. Factory test report to verify compliance with 1.6.B.

1.6 QUALITY ASSURANCE

A. The Fuel Management Control Cabinet shall be manufactured and labeled in accordance with UL508A.

B. The fuel oil forwarding system/equipment shall be factory inspected and tested in its entirety prior to shipping. Testing shall include hydrostatic and vacuum testing of pump set piping, pump-set shall be tested at design pressure, control panel(s) point to point wiring, and a complete simulation of the distributed control system including all field devices (level transmitters, control valves, leak sensors, etc…)

C. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks and piping.

D. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.

E. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

F. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

G. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.

D. Store PE pipes and valves protected from direct sunlight.

E. Deliver equipment with factory installed wooden skids and lifting lugs; pack components in factory fabricated protective containers.

F. Handle equipment carefully to avoid damage to components, enclosures, and finish.

G. Store equipment in clean, dry spaces and protect them from weather and construction debris.

H. Comply with manufacturer's rigging instructions for unloading equipment and moving equipment to final location for installation.

I. Loose-shipped items shall be packed, protected and secured with units.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Fuel-Oil Service: Do not interrupt fuel-oil service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fuel-oil supply according to requirements indicated:

1. Notify Engineer no fewer than 5 days in advance of proposed interruption of fuel-oil service.
2. Do not proceed with interruption of fuel-oil service without the Engineers written permission.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-oil oil pump set, fuel oil storage tanks and fuel oil specialties and related equipment that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F

1) Structural failures including cracking, breakup, and collapse.
2) Corrosion failure including external and internal corrosion of steel tanks.

b. Warranty Period: 30 years from date of Substantial Completion or 18 months from equipment delivery.

2. Flexible, Double-Containment Piping and Related Equipment:

a. Failures due to defective materials or workmanship for materials installed together, including piping, dispenser sumps, entry boots, and sump mounting adapters.
b. Warranty Period: 30 years from date of Substantial Completion.

B. Fuel System Equipment manufacturer shall provide a one-year warranty on all parts and appurtenances from date of system acceptance or 18 months from equipment delivery, whichever comes first.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
2. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
3. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

a. Material Group: 1.1.
b. End Connections: Threaded or butt welding to match pipe.
c. Lapped Face: Not permitted underground.
d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
e. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.

4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. Fittings at the tank or equipment, shutoff valves and other fuel oil flow and control devices may be screwed or flanged.

2.2 PIPING: DOUBLE WALL

A. Acceptable manufacturers subject to compliance with the specifications:

1. Perma Pipe
2. Insul Tek
3. Tricon

B. General

1. All below ground & above ground outdoor secondary containment piping shall be an engineered and totally prefabricated DOUBLE-PIPE type containment system. Carrier pipe shall be protected from the exterior environment by the secondary containment. The system supplier shall have at least 10 years of experience in the manufacture of secondary contained pipe systems having a factory integrated complete cable leak detection/location alarm system. All straight sections, fittings and other accessories shall be factory prefabricated to job dimensions. Secondary steel containment & joints completed at the factory shall be 100 percent air-tested with reports. The system shall be manufactured to allow the placement/replacement of the leak detection cable in the secondary containment. The containment shall be drainable, dryable and air pressure testable. Contractor fabricated systems, whether built on site or off site, shall not be acceptable.

2. All secondary containment systems shall be equipped with a cable leak detection/location system supplied by the manufacturer of the double piping containment system.

3. The secondary containment shall not be exposed to pressures which exceed the maximum for the selected containment material.

4. The secondary containment manufacturer is responsible & shall supply a complete engineered design with state stamped drawings for a submittal, including layout drawings, leak detection routing, catalog sheets, material data and pipe stress and end load calculations in accordance with ANSI B31.3 latest edition. The calculations shall be stamped by a Registered Professional Engineer.

C. Carrier Pipe

1. Carrier pipe shall be standard weight carbon steel, ASTM A-53, Grade B, seamless. All joints shall be butt welded for sizes 2-1/2 inches and greater and socket or butt welded for 2 inches and below. Where possible, straight sections shall be supplied in 40 foot random lengths with 6 inches of piping exposed at each end for field joint fabrication.

D. Secondary Containment

1. The secondary containment shall be a fabricated out of carbon steel, in accordance with ASTM A-135 Grade B or ASTM A-53 Grade B, to the thickness specified below:

a. Diameters Minimum Thickness

3" - 5"	Schedule 40
6" - 26"	Schedule 10 or 10 Gauge

2. The carbon steel containment pipe shall have a 10 Gauge Steel Casing with 100 Mils of Fiberglass coating. The cladding shall be applied to a shot blasted steel surface that meets SSPC SP-7 surface finish.

3. The cladding on straight sections shall consist of multiple layers of helical windings of continuous glass reinforcements applied at a winding angle of 58o to 62o. The cladding on fittings shall consist of either a chopped spray-up polyester resin/fiberglass reinforcement composite or wrapping of glass cloth fully saturated with a two part catalyst adhesive.

E. Field Joints

1. All field joints shall be air tested prior to any coating or joint covering. A double layer 24” & 36” wide heat shrink shall be applied over the exposed steel containment at all field joints or any field repairs. No Backfilling of joints is permitted prior to inspection by piping system manufacturer field tech.

F. Pipe Supports

1. Supports shall be designed and factory installed by the secondary containment manufacturer. Support spacing shall be determined by the manufacturer based on pipe diameter, pipe material and operating temperature of the product pipes. In all cases, pipes within the secondary containment shall be supported at not more than 10 foot intervals. These supports shall be designed to allow for continuous air-flow and drainage of the secondary containment in place. When used with a leak detection/location cable, the supports shall have a 3/4" ID Type 304 flared end stainless steel guide tubes that facilitate cable pulling and prevent cable damage during pulling operations. No plastic supports will be allowed.

G. Subassemblies

1. End seals and other subassemblies shall be designed and factory prefabricated to prevent the ingress of moisture into the system. All subassemblies shall be designed to allow for complete draining of the secondary containment.

H. Leak Detection/Location System

1. The sensor cable, connectors (probes) and jumpers shall be supplied by the manufacturer of the monitoring unit(s). The cable sensing principal shall provide for continuous monitoring while short lengths of the cable are in contact with liquids, without altering the systems sensitivity and/or accuracy. The sensor cable shall be designed as follows:

2. AGW-GOLD

a. Sensor cable shall be of fluoropolymer and polymer coated wire construction, with no exposed metal parts. Cable shall detect water-based, chemical and hydrocarbon liquids. The sensor cable can be flushed and dried in-place and will not require replacement after a leak event of any volatile liquid. The cable shall have a breaking strength of at least 100 pounds and shall be resistant to corrosion, abrasion and most chemicals tested in accordance with exposure procedures in ASTM D543.

I. Installation

1. The installing contractor shall install the system in accordance with the directions provided by the manufacturer and as approved by the architect and engineer. The secondary containment shall be air tested at 10 psig and the product piping shall be hydrostatically tested to 50 psig or 1½ times the operating pressure, whichever is greater. The test pressures shall be held for not less than one hour. The contractor shall strictly adhere to the installation guidelines supplied by the system manufacturer and shall keep the secondary containment system clean and dry at all times during the installation process.

J. Backfill

1. A 4-inch layer of sand or fine gravel shall be placed and tamped in the trench to provide a uniform bedding for the containment pipe. The entire trench shall be evenly backfilled with a similar material as the bedding in 6 inch compacted layers to a minimum height of 6 inches above the top of the piping system. The remaining trench shall be evenly and continuously backfilled in uniform layers with suitable excavated soil. Bedding and backfill materials shall be as recommended by the manufacturer.

2.3 PIPING SPECIALTIES

A. Flexible Connectors: Comply with UL 2039.

1. Metallic Connectors:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) American Flexible Hose Co., Inc.
2) Flexicraft Industries.
3) Metraflex Company.
4) Or Equal

b. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
c. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
d. Maximum Operating Pressure: 150 psig.
e. End Connections: Socket, flanged, or threaded end to match connected piping.

f. Maximum Length: 24 inches.
g. Swivel end, 50-psig maximum operating pressure.
h. Factory-provided anode.

2. Nonmetallic Connectors: Comply with UL 2039

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Preferred Utilities
2) American Flexible Hose Co., Inc.
3) Flexicraft Industries.
4) Metraflex Company.
5) Or Equal.

b. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
c. PFTE bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
d. Minimum Operating Pressure: 150 psig.
e. End Connections: Socket, flanged, or threaded end to match connected piping.
f. Maximum Length: 30 inches.
g. Swivel end, 50-psig maximum operating pressure.
h. Factory-provided anode.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60 mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

E. Gauges: Comply with requirements specified in Division Section 23 “Meters and Gauges For HVAC Piping”.

2.4 JOINTS AND JOINING MATERIALS

A. All piping joints and connections shall be made per the requirements below and as per local code:

1. All threaded joints and connections shall be made tight with lubricant or pipe joint compound approved for use with fuel oil.
2. Unions requiring gaskets or pickings, right or left couplings, and sweat fittings employing brazing material having a melting point of less than 1,000F shall not be used in oil lines.
3. Cast-iron fittings shall not be used in oil lines.

B. Threaded Joints:

1. Threads shall conform to ASME B1.20.1
2. Joint Compound: Applied to male threads only and suitable for fuel oil.

C. Welded Joints:

1. All joint surfaces shall be cleaned by approved procedure
2. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Brazed Joints:

1. All joint surfaces shall be cleaned.
2. An approved flux shall be applied where required
3. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

E. Nonmetallic Pipe:

1. Joints between nonmetallic pipe or fittings shall be installed in accordance with the manufacturer’s instructions for the labeled pipe and fittings.

2.5 MANUAL FUEL-OIL SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with UL 842.

1. CWP Rating: minimum 125-psig
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
5. Service Mark: Initials "WOG" shall be permanently marked on valve body.

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with UL 842.

1. CWP Rating: minimum 125-psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in the valve schedule.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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

    a. Conbraco Industries, Inc.; Apollo Div.
    b. Milwaukee Valve.
    c. Perfection Corporation; A Subsidiary of American Meter Company.
    d. Watts Industries, Inc.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body pack-nut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in the valve schedule.
8. CWP Rating: 600-psig.
9. Service Mark: Initials "WOG" shall be permanently marked on valve body.

2.6 SPECIALTY VALVES

A. Pressure Relief Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Preferred Utilities Manufacturing Company
    b. Anderson Greenwood; Division of Tyco Flow Control.

c. Fulflo Specialties, Inc.
d. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.

2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Body: Brass, bronze, or cast steel.
4. Springs: Stainless steel, interchangeable.
5. Seat and Seal: Nitrile rubber.
6. Orifice: Stainless steel, interchangeable.
7. Factory-Applied Finish: Baked enamel.
8. Maximum Inlet Pressure: 150-psig.
9. Relief Pressure Setting: 15% above operating pressure (set in field).
10. Gasketed adjustment screw cap (machined bronze)

B. Oil Safety Valves: Comply with UL 842.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anderson Greenwood; Division of Tyco Flow Control.
b. Suntec Industries Incorporated.
c. Webster Fuel Pumps & Valves; a division of Capital City Tool, Inc.
d. Preferred Utilities Manufacturing Corporation.
e. Watson-McDaniel.

2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Body: Brass, bronze, or cast steel.
4. Springs: Stainless steel.
5. Seat and Diaphragm: Nitrile rubber.
6. Orifice: Stainless steel, interchangeable.
7. Factory-Applied Finish: Baked enamel.
8. Manual override port.
9. Maximum Inlet Pressure: 60 psig.
10. Maximum Outlet Pressure: 3 psig.

C. Emergency Fusomatic Shutoff Valves: Comply with UL 842.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Morrison Bros. Inc.
b. Highfield.
c. OPW.
d. Preferred Utilities Manufacturing Corporation.

2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Single poppet valve.
4. Body: ASTM A 126, cast iron.
5. Disk: FPM.
6. Poppet Spring: Stainless steel.
7. Stem: Plated brass.
8. O-Ring: FPM.
9. Packing Nut: PTFE-coated brass.
10. Fusible link to close valve at 165 deg F.
11. Thermal relief to vent line pressure buildup due to fire.
12. Air test port.
13. Maximum Operating Pressure: 0.5 psig.

D. Check Valves:

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

    a. Worcester.
    b. Conbraco Industries, Inc.; Apollo Div.

2. Body: Bronze.
3. Ends threaded, flared or socket weld.
4. Type: Lift.
5. CWP Rating: 600 psig.
6. Service Mark: Initials “WOG” shall be permanently marked on the valve body.

E. Oil Lever Gate Valve: Emergency fuel line shut-off.

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

    a. Preferred Utilities Manufacturing Corporation.
    b. OPW.
    c. Highfield.
    d. Morrison Bros, Inc.

2. Size: 3/4 inch to 3 inch, quick closing spring mechanism.
3. Body: Bronze.
4. Disc: Bronze.
5. Ends: Threaded.
6. Fusible Links: 165 deg F. melting temperature.
7. Limit Switch Assembly: For wiring to fuel oil management system.

F. Anti Siphon Valve: UL listed for fuel oil.

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

    a. Preferred Utilities Manufacturing Corporation.
    b. EBW
    c. Universal Valve

2. Size: 1/2 inch to 3 inch
3. Body: Heavy bronze with oil proof gasketing.
4. Operation: Spring loaded poppet, factory set, sized to meet flow and vertical height requirements of the system.
5. Ends: Threaded.

G. Tank Selector Valve:

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

    a. Preferred Utilities Manufacturing Corporation.
    b. Kraissl.

2. Size: 1-1/4 inch to 4 inch
3. Body: Cast iron.
4. Type: Plug.
5. Single Operating Lever, 1/4 turn.
6. Ends: Threaded or flanged, six connections.

H. Back Pressure Regulating Valve:

1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

    a. Preferred Utilities Manufacturing Corporation.
    b. Webster Fuel Pumps and Valves: A division of Capital City Tool, Inc.
    c. Watson McDaniel.
    d. Cashco.
    e. Fischer.

2. Size: 1 inch.
3. Body: 250 lb cast iron.
4. Range: 3 to 125 psi.
5. Operation: Adjustable spring.
6. Diaphragm: 6 ply teflon composition or stainless steel.
7. Ends: Threaded.

I. Foot Valve

1. Provide at the bottom of the tank suction stub a single-poppet foot valve suited for service in which drip tight shutoff is required.
2. The body shall be constructed of unleaded bronze with a spring-loaded poppet assembly.
3. The foot valve shall be complete with an inlet basket style strainer with a minimum open area ratio of 3 to 1 versus the nominal pipe size.
4. Foot Valve shall be provided with a Foot Valve Extractor Fitting as per Preferred Utilities Mfg. Corp. Model Number 11988 or equal.
5. The foot valve shall be a Preferred Utilities Mfg. Corp. Model 60 or equal.

J. Motorized Ball Valves (3-way)
1. The Automatic Ball valve(s) shall be electric actuator operated. The valve actuators shall be NEMA 4/4X/6 and have (2) auxiliary end switches to prove valve position. The valves shall be equipped with manual overrides to allow the facility operators to manually position the valves in the event of an actuator or control failure.
   a. Valve to be 3-way design. Valves are full port, ANSI 150 class with Carbon steel body, AISI 316 SS ball, 316 stainless steel stem, virgin PTFE thrust washer, AISI 316 SS gland sleeve, 1018 carbon steel gland retainer, Virgin PTFE compressed graphite gland packing and seat.
   b. Valve includes a bottom loaded stem with “packing gland” style seal design and a threaded seat retainer.
   c. Ball construction is solid for structural integrity and reduced flow turbulence. Valve to be:
      1) Apollo
      2) Microfinish
      3) Watts
2. Reversing Electric Actuator: Each ball valve to have a NEMA 4/4X/6 reversing electric actuator with manual override and a minimum of two (2) auxiliary position switches.
   a. Actuator assembly to have a largely dimensioned and naturally self-locking output gear.
   b. S4-30% duty rated motor with class F insulation and thermal protection.
   c. Two mechanical stops
   d. A high visibility position indicator shall be supplied for ease of valve position viewing from greater distances minimum 12’.
   e. Emergency hand-wheel operator mounted on final reduction stage.
   f. Position switches to be SPDT 10-amp cam operated and adjustable over entire range of travel.
   g. Cover bolts to be stainless steel
   h. Actuator shall be Bernard Controls or equal.

2.7 Fuel Oil Management System (Leak Detection and Level Monitoring)

A. Acceptable manufacturers subject to compliance with the specifications:

1. Preferred Utilities
2. Viking Pump

3. IMO Pump

B. Provide a factory assembled "Packaged" Fuel Oil Management System. System to be factory fabricated/tested and certified as a complete unit. Field assembled units are not acceptable.

C. The Fuel Oil Management System shall consist of a distributed control system based on individual microprocessor-based controllers with field expandable plug-in Input/Output modules communicating over a redundant master-less network and shall include the capability to simultaneously communicate with a Building Management System (BMS) via Modbus and/or BACnet protocol. The system shall be capable of; main storage and day tank product level monitoring including alarms and leak detection, and piping cable system leak detection for double wall pipe, and include LCD operator display, manual back-up stations, time and date stamped alarm and event summary.

D. Fuel Oil Management System

1. Provide a fuel oil management system consisting of distributed peer-to-peer and configurable logic controllers for monitoring and controlling the complete fuel oil system.
2. The control panels shall be wall mounted with provisions or future wiring to fuel pump control panel.
    a. Control panels shall be a NEMA 4 rated.
    b. Each panel will include a distributed controller, color touchscreen operator interface, motor starters, control switches and indicators, with labelled terminal strips for all field wiring.
    c. The control cabinets shall be completely pre-wired and factory programmed and tested to ensure job site reliability.
3. The field mounted fuel oil specialties shall be field wired to the day tank control panel.
4. Control and Monitoring Hardware
    a. Control panels shall be UL508A listed
    b. A single-phase step-down transformer shall be provided for single point power connection.
    c. Distributed controller
        1) Supply a distributed control system composed of up to ten individual microprocessor-based PLCs communicating via a redundant peer-to-peer master-less digital network. Network shall be capable of communicating up to 4,000 feet between nodes without repeaters or boosters.
        2) Multiple controllers shall communicate digitally using a pair of redundant two-wire communication networks. If either communication network loses communication, the other network will resume communication and provide uninterrupted control to the entire network. If any controller, or node, in the network shuts down or stops communicating, an alarm will sound, and the other controllers will continue to operate.
        3) The control system logic and calibration data shall be stored in a non-volatile memory that does not require battery backup.
        4) Each microprocessor controller shall include, but not be limited to, the following inputs and outputs:

a) (24) 120 VAC digital inputs
b) (5) 2 A relay outputs
c) (5) 1/2 HP (10 A) relay outputs
d) (8) loop-powered 4-20 mA analog inputs
e) (3) 4-20 mA analog outputs

d. Control panel face shall include:
1) 10” color touchscreen Human Machine Interface (HMI)
2) Electronic tank gauging, including leak detection and overfill alarm system(s).
3) Control Power On-Off switch
4) Hand-off-Auto (HOA) switches for pumps
a) HOA switches shall be hard wired and shall be able to operate the pumps in the event of a controller failure.
5) Alarm horn and alarm silence pushbutton

e. Human Machine Interface (HMI):
1) The control system shall include a 10” color touchscreen HMI.
2) The HMI touch screen shall have a bright TFT display with full 256-color support.
3) The touchscreens shall be pre-programmed at the factory with graphic pages for operation, setup, troubleshooting, and alarm indication
4) Each touchscreen shall be capable of displaying information from any of the controllers in the distributed control system.

f. External/BMS Communications
1) The Distributed control system shall communicate to an external controller, building automation system, or energy management system via Modbus RTU, Modbus TCP/IP, and BacNet IP protocols.
2) Tag database to be provided when system to be integrated into a building automation or other third-party control system.

g. Alarm and Event Logs: The control system shall include alarms, events and operator actions memory minimum.
1) Provide an alarm display page for viewing the most recent 8 alarms/events with scrolling capability to view the complete 200-point alarm/event memory.
2) Each event and alarm condition must be displayed with a distinct, descriptive, English language description and time and date stamp.
3) New alarms shall trigger the common alarm output relay. Events shall be recorded but shall not trigger an alarm. A dedicated alarm silence button shall silence the alarm output.
4) All alarms, events and system status shall be available via Modbus RTU, Modbus TCP/IP, or BacNet IP protocol
5) The control system shall record and annunciate the following alarms: Pump Thermal Overload, Pump Loss Of Flow, Pump Set Failure, Riser leak, Containment pipe leak (each sensor), Day Tank Leak, Day Tank High level, Day Tank Low level, Day Tank (and main tank) Vent, main tank overfill.

6) The control system shall record the following events: Pump Started, Pump Control Switch in "Off" position, Pump Set Prime Test OK, return pump and levels switches Test OK, and Pump Selected as Lead

5. Quality Assurance: The Fuel Management Control Cabinet shall be manufactured and UL508A labeled. The factory assembled control cabinet must be inspected for proper wiring methods, fusing, etc., and shall be labeled UL508A.

E. Sequences of Operation

1. Main Fuel Oil Storage Tank(s) Gauging, Overfill Prevention and Leak Detection
   a. Mounted on and integral to the pump set control panel shall be an electronic tank gauge and leak detection system.
   b. The Fuel Oil Management system shall monitor the main storage tank level sensor, backup high level switch, and discriminating leak sensor monitoring.
   c. Provide a continuous display of tank content in both gallons and inches of product within the main storage tanks.
   d. Upon storage tank level greater than 90% full, a high-level alarm will be sounded both locally and at the remote overfill alarm. Pump running circuit of the return pump(s) shall be interlocked with the High Level Switch at the Main Control Cabinet, which will provide electronic instructions to shut off all pumps in the system if a return pump is the source of the overfilling, or alarm only if the cause is due to a delivery filling error.
   e. Upon activation of the backup hi-hi (95%) level switch an alarm will be sounded both locally and at the remote overfill alarm.
   f. Upon storage tank level less than 30% (adjustable) a low-level alarm will be sounded locally at the control panel.
   g. The Fuel Oil Management system will monitor the status of the storage tank vault leak sensors and sound an alarm in the event of a leak.
   h. Provide data recall of the instantaneous display of tank content at the time of leak alarm condition.
   i. The Fuel Oil Management system shall include an overfill alarm circuit test push button to provide instantaneous proving of audible and visual alarm circuitry associated with instrument overfill alarm contact.
   j. The controller must be field expandable using plug-in input modules to monitor up to 8 storage tanks and 24 discriminating leak sensors.
   k. Provide all equipment capabilities specified in this paragraph even if level and leak sensors are not included in this project.

2. Day Tank Overfill prevention and Leak Detection
   a. The Fuel Oil Management system shall monitor the day tank multi-point level switch and high-high level switch (high-high level switch is installed in the tank vent), and rupture basin leak detector.
   b. Upon activation of the high or high-high level switch the fuel oil management system shall sound an alarm and shutdown all active fuel oil transfer pumps.

c. The Fuel Oil Management system will monitor the status of the day tank leak detector. Upon activation of the leak detector the fuel oil management system shall sound an alarm and shutdown all active fuel oil transfer pumps.

3. Fire Safety Lever Gate Valve monitoring:
   a. The control panel shall monitor the field installed lever gate valve(s) position(s) and sound an alarm when a valve is closed. When a fire valve on the pumps discharge or suction is closed, shut down the respective fuel oil pumps.

F. Factory Tests

1. The Pump Sets and Fuel Oil Management System shall be factory tested prior to shipment. Factory test shall include pressure, vacuum and a full functional test.
   a. Pressure Test - The pump set shall be pressure tested using diesel/#2 oil at 15% above rated pressure. The testing duration shall be 4 hours.
   b. Vacuum Test - The pump set shall be brought to a vacuum greater than 25"Hg. The testing duration shall be 4 hours.
   c. Operational Tests - The pump set shall be connected to a fuel oil tank and discharge piping and operated at design pressure.
      1) Motor amps shall be recorded at no load and design pressure for each motor. The motor amps shall be within 10% of rated motor amps.
      2) During the test the relief valve shall be set and tested.
      3) The pump set(s) and Fuel Oil Management control panel(s) shall be wired to a simulator to perform a complete functional test of the system logic per the sequence of operation.
      4) All test data shall be recorded
   d. A certificate of factory testing, together with a copy of the wiring and arrangement diagrams shall be placed in the control cabinet prior to shipment.
2. Factory tests may be witnessed by the Engineer/Owner. Notify the Engineer 14-days in advance of scheduled tests. Submit all test reports to the Engineer.

2.8 Main Fuel Oil Storage Tank (UST)

A. Provide One (1) 20,000-gallon horizontal UL 1316 fiberglass cylindrical double wall with interstitial brine fuel oil storage tank.

B. Acceptable manufacturers subject to compliance with the specifications:

1. National Oilwell Varco – Containment Solutions Hydroguard
2. Xerces Corporation

C. Dimensions, capacities and connections as shown on drawings and schedules

D. Construction: Fabricated with fiberglass-reinforced polyester resins; suitable for operation at atmosphere pressure; fabricated or the following loads:
   1. Depth of Bury: 7 feet from top of tank to finished surface

2. External Hydrostatic Pressure: To withstand general buckling with safety factor of 5:1 if hole is fully flooded
3. Surface Loads: AASHTO's "Specifications for Highway Bridges," H-20 axle loads of 32,000 lbs

E. An air test of the primary tank should be done above ground prior to installation. Pressure should not exceed 5 psi.

F. Backfill consisting of sand, #8 crushed stone (#8 crushed aggregate ASTM D-448) or fine gravel, shall be placed along bottom side of tank by shoveling and tamping to ensure the tank is fully and evenly supported around bottom quadrant. The backfill shall be deposited carefully around tank and to a depth over tank to avoid damage to coating

G. Fittings to be supplied as shown on the drawings and as per jobsite requirements. All fittings to be located on the top centerline of the tank. Openings on the tank shall be as follows:

1. One (1) Fill line
2. One (1) overflow/return
3. One (1) operating vent
4. One (1) Manway with:
   a. One (1) Pump suction
   b. One (1) Filtration/fuel polishing system supply
   c. One (1) 4" NPT/Flange for level transmitter
   d. One (1) Spare
5. One (1) Manway with:
   a. One (1) System return
   b. One (1) Filtration/fuel polishing system return
   c. Two (2) Spare
6. One (1) high level switch connection
7. One (1) Manway with internal ladder

H. Lifting Lugs: For handling and installation.

I. Fill Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom.

J. Pump Suction Tube: Install a foot valve on the bottom of the pump suction tube, terminate pump suction tube 4" from bottom of tank

K. Filtration Suction Tube: Install a foot valve on the bottom of the filtration suction tube, terminate filtration suction tube 2" from bottom of tank

L. Return Tube(s): Extension of fitting into tank, terminating 6 inches above tank bottom and on opposite of tank from pump suction tube.

M. Main Storage Tank Accessories

1. Main Storage Tanks Level Transmitter
   a. Liquid Level Transmitter: Shall consist of aluminum, submersible (NEMA 6P) electronics head external to the tank and a float internal to the tank. The float shall be connected to the sensor head by a flexible stainless cable. The flexible cable shall allow installation or removal when overhead obstructions are present.
   b. The sensor shall include an external test mechanism to allow overfill alarm and full tank calibration checks without removing the sensor from the tank. Tests that electronically simulate a high tank level instead of physically moving the float are not acceptable.
   c. For tanks reinforced with internal crossbars for structural integrity use a stilling well to prevent interference from any obstructions.
   d. The assembly shall mount to the tank through a standard 4" 125/150 lb flat faced flange opening with standard bolt pattern.
   e. The mechanism's control head shall be constructed of 1/4" cast aluminum. This sealed transducer housing shall encapsulate all transmitter electronics in non-conductive oil and be moisture tight.
   f. Sensor assembly shall be water resistant and capable of operating in a submerged or manhole environment without damage.
   g. The unit shall only require 14-inches of clearance between the flange and any overhead obstructions.
   h. If buried suitable access for removal of the wire floats assembly must be provided. Tank gauge calibration shall be possible at any tank fluid level (empty, part full, or full.)
   i. The sensor operation shall be suitable for use with non-corrosive fluids and fuel grades up to and including No. 6 fuel oil.
   j. The level sensor shall be Preferred Instruments Model TG-EL-WF-C or equal.

2. Main Oil Storage Tank Leak Detectors
   a. Provide electro-optic leak detecting for the main tank area, pump area and containment pipe and as shown on the drawings.
   b. Detectors shall be solid state and discriminate between oil and water.
   c. Leak status oil/water shall be displayed by (2) LED's.
   d. All leak sensors shall be intrinsically safe, have continuous electronic checking, fail safe to an alarm condition.
   e. Leak sensors mounted in sumps, or floor mounted within tank vault shall be provided with guards.
   f. Provide 20-gauge wiring and tape all exposed shields. Connect shields only where shown on the electrical submittals supplied by the manufacturer. Do not run low voltage wiring in conduits with high voltage (i.e., 110 volts).
   g. Leak sensor(s) shall be as manufactured by Preferred Instruments Model HD-A2-C or equal.
   h. Interstitial Monitoring
      1) The tank shall have an integrally mounted annular space reservoir installed on the tank for factory-installed brine and continuous hydrostatic monitoring. The reservoir shall be constructed of fiberglass reinforced plastic materials and be included in the tanks warranty

2) The monitoring fitting for the monitoring space shall be a 4" NPT fitting
3) The monitoring system shall be capable of detecting a breach in a the inner and outer tank when the primary tank is empty, partially or completely full and the ground water table is below the tank bottom, and partially or completely full and partially or completely submerged in groundwater.
4) The leak detection performance of the monitoring system shall be tested and verified by a qualified independent consultant to detect leaks in the primary or secondary tank walls as small as 0.10 gallons per hour within one month
5) The monitoring system shall be capable of a precision tank test that is listed by the National Work Group on Leak Detection Evaluations (NWGLDE) and be listed as a continuous interstitial monitoring method (liquid filled) by NWGLDE
6) Monitoring fluid solution used in the monitoring space shall be compatible with the tank and be of a contrasting color to the tank
7) Double float reservoir sensor shall be compatible with brine and provide two alarm points 10" apart and shall be provided with the tank.
8) The monitoring system shall be capable of connecting into the leak detection monitoring and alarm system and/or fuel oil management system

3. Main Oil Tank Back-up High Level Switch
   a. Provide a backup high level float operated switch
   b. Switch shall be installed through a single 1 ¼" tapping on the top of the tank
   c. Switch shall be manufactured entirely of nonferrous material and complete with switches rated at 100 Watts.
   d. Electrical connections shall be made external to the tank in a NEMA 4 head assembly approved by Underwriters Laboratories.
   e. Switch shall be Model PLS-1 as manufactured by Preferred Utilities Mfg. Corp., or equal.

4. Tank Vent Protector
   a. Fuel oil storage Tank Vent Protector shall be the full size of the vent pipe in accordance with NFPA 30 Flammable and Combustible Liquids Code and NFPA 31 Standard for the Installation of Oil-Burning Equipment.
   b. It shall be of aluminum construction and provided with standard pipe threads.
   c. Provide a tank vent protector and emergency pressure relief valve as manufactured by Preferred Utilities Mfg. Corp., or equal.

5. Tank Overfill Alarm Panel
   a. Construction to be of stainless steel
   b. Performance Rating: NEMA4X
   c. Alarm test push button shall be included
   d. Model: FA-AV-SS by Preferred Utilities Mfg. Corp. or equal.
   e. Main Tank Level Display to be built in, wired, and tested by the manufacturer.

6. Vent line shall be equipped with a vent line switch similar to Preferred Model RBS or equal. Switch shall be controlled by Fuel Master Control Panel. Mount switch as close to the top of the tank as possible, less than one foot above the top of the tank.

7. Overfill Prevention Valve: The tank shall have an overfill prevention valve installed in the fill pipe. The valve shall close automatically at 90% of tank capacity. The valve shall incorporate a drop tube extending to within 6" of the tank bottom. Valve shall be rated for pressurized fuel delivery. Preferred model 61F or equal for pumped fill.

8. Lockable Fuel Oil Fill Box: Fuel fill box shall include a top seal, tight fill adapter and locking fill cap. The spill compartment shall incorporate flexible bellows to prevent damage from frost heave, normal settling, etc. The drain valve shall close with tank pressure to prevent leakage during tank testing or filling. A hand pump shall be included.

2.9 Cable Leak Detection System

A. The Leak Detection system will be an integrated into the fuel oil management/pump control panel(s) described in section 2.6, for complete system integration and single point of responsibility.

B. Provide complete cable leak detection and location system for generator flow and double wall piping consisting of:

1. A microprocessor-based monitoring unit, sensor cables, probes, system layout map and auxiliary equipment required to provide continuous monitoring of the sensing string(s) for leaks (growing and multiple), shorts, breaks and probe activations. If any of these conditions should occur at any point along the cable, an alarm shall sound, type of condition and location shall be clearly identified.
2. Systems that lose accuracy or alarm due to build-up of dust, dirt or other dry contaminants shall not be acceptable. The system shall monitor double contained piping, tanks, generator sets, single wall piping and/or trenches
3. The manufacturer shall have at least ten years' experience in supplying leak detection systems.
4. Approvals: The system shall be UL Listed (USA and Canada), and CE certified.
5. When Zener barriers are required for intrinsically safe sensor circuits for hazardous areas the components shall be UL Listed (USA and Canada), ATEX and IECEx approved for Class I, Division 1, Groups C & D or Zone 0, Group II B locations FM Approval available including Class Number 7745 (Hydrocarbon Leak Detectors).
6. Manufacturer: The fuel oil management/pump control system shall incorporate the PAL-AT Leak Detection and Location System manufactured by PermAlert, Niles, Illinois.

C. Performance

1. The cable leak detection system shall locate the point of origin of the first liquid leak or fault (break/short/probe) within 0.25% (0.6% for hydrocarbons) of the sensor string length, or 6 feet, whichever is greater.
2. The system shall identify the type of alarm leak/break/short/probe as well as the location.
3. The system shall be able to monitor (detect and locate) with up to 100' of cable wetted without significant inaccuracy in location.
4. For applications requiring U.S. EPA Third Party Approval the system shall be evaluated by an independent third party according to the Third-Party Procedures developed according to the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Liquid-Phase Out-of-tank Product Detectors." The evaluation results shall verify the system manufacturer's claim regarding sensitivity, range and other performance data.
5. Sensing String Length: The system shall be capable of monitoring up to 7,500 feet of cable per sensor string from a single monitoring unit.
6. Multilevel Leak Alarms and Multiple Leaks: The system shall be capable of monitoring (detecting and locating) for initial leaks, growing leaks (multilevel alarm) and multiple leaks on the sensor cable.
7. The system shall be capable of integrating discriminating point leak detectors and float-type leak detectors.
8. Breaks and Shorts: The system shall be capable of identifying the location of breaks and shorts on the cable. When either of these faults occurs, an alarm shall sound and a display visible on the front of the monitoring unit shall clearly indicate the type of fault, i.e. BREAK or SHORT and display the location of the fault. Systems that cannot detect and identify shorts on the sensor cable are not acceptable.
9. Liquids Detected: The system shall be capable of detecting all liquids, including, but not limited to aqueous, hydrocarbon, conductive and nonconductive liquids.
10. Remote Annunciation. The system shall provide Modbus TCP and Modbus RTU, BACnet IP, and dry contact relays for remote indication of an alarm condition.
11. Archives: The system shall record significant events in nonvolatile memory. A minimum of 900 events shall be stored. When the memory becomes full, the recorded events shall be deleted from memory on a First in-First (FIFO) out basis. Each recorded event shall include the time and date that the event occurred. Archives shall be retrievable through the communication ports.
12. System Status. The system shall continuously provide positive indication that it is monitoring the sensing string and the status of the sensing string. The system clock shall provide the time and date on the LCD of the monitoring panel. The system clock shall be programmable by the user. A time and date indication shall be included for all events recorded in memory.
13. Security. The system shall have assignable password security to provide for varying levels of system access. A minimum of 20 passwords shall be available within the system. The system shall not permit unauthorized modifications to the sensing string to be made (i.e. shortening the cable length) without causing an alarm condition.
14. Sensor Types. The system shall be capable of monitoring sensor cables, probe sensors and switch sensors (such as float switches, pressure switches, etc.) from the same monitoring panel.
15. Sensitivity. The system shall not detect incidental liquid contact that is not at least equivalent to a small puddle, 3 inches in diameter. The sensitivity of the system shall be

field adjustable to increase or decrease the amount of wetted cable needed to cause an alarm from several inches to several feet.

D. Products

1. Monitoring Unit:
   a. The monitoring unit shall be microprocessor-based and capable of monitoring up to 7,500 feet of sensing string per cable, including sensor cable, probes and jumper cable, depending on cable type.
   b. The monitoring unit shall indicate when any liquid or growing liquid contacts the sensor cable by sounding an alarm, actuating output relays, and displaying a message that states a leak has been detected and shows the location of that leak on the sensing string.
   c. The monitoring unit shall include an alarm horn, alarm light, and color touchscreen operator interface.
   d. The monitoring unit power requirements shall be 120/240 VAC, 50 VA, 50/60 Hz, single-phase or 24 VDC, 24VA.
   e. Monitoring units shall be equipped with an RS-232 and an RS485/232 communication ports and a minimum of one power failure relay, one common and one per cable SPDT output relay, rated for 250 VAC, 10 A.
   f. The ability to locate a leak shall not depend on battery backed up functions. In the event of power failure, system conditions and parameters shall be stored in nonvolatile memory allowing the unit to automatically resume monitoring, without resetting, upon restoration of power.
   g. An on-off switch shall be provided in the panel for servicing.
   h. The monitoring unit shall be enclosed in the NEMA 4 pump control enclosure.
   i. The Zener Barrier Panel (if required) shall provide connections for intrinsically safe sensor circuits for use in Class I, Division 1, Groups C and D and Zone 0, Group IIB Hazardous Locations.

2. Sensor Cable
   a. The sensor cables shall be of coaxial construction consisting of an insulated copper center conductor, a suitable spacer material, and an insulated outer braid with a protective over-braid.
   b. All coaxial sensor center conductors must not be less than 14 AWG for mechanical strength.
   c. All cables must be capable of field installation of connectors by trained technicians.
   d. The cable shall be available in lengths up to 1,500 feet in bulk spools.
   e. All cables must be field repairable by trained technicians.
   f. Cable on flat surfaces shall have hold down clips every 8 feet and cable identification tags every 50 feet.
   g. Cable shall have the ability to detect hydrocarbons only and have a center core that allows hydrocarbon penetration.

E. General
   a. The cable leak detection system shall be installed per the manufacturer's recommended installation procedures.

b. All local, state and federal codes and requirements shall be followed.
c. The system shall be installed by properly trained personnel.
d. Graphic Locator Maps: A location map shall be provided with the system by the installing contractor; indicating the "As Installed" system configuration and sensing string layout. Footage along the cable shall be provided as references to locate leaks. Footage shall be based upon Calibration Points taken per Section e below
e. Calibration Point: The installing contractor shall be responsible for taking and recording calibration points along the sensing string per the manufacturer's recommended procedures. All cable not in containment piping shall have cable tags every 50 feet.
f. Field Test of System:
    1) Tests shall be performed to demonstrate the ability of the system to detect and locate breaks, shorts and probes on the sensor string.
    2) The cable shall be shorted with the alarm and location verified.
    3) Leak testing shall be done per the following procedure to verify operation and ability to work with condensation pools of other static moisture.
        a) Wet the sensor cable near the start of the sensor string and silence/acknowledge the detection/location alarm.
        b) Increase the amount of cable wet and verify the second alarm and location. Clear the alarm queue.
        c) Wet the sensor cable near the end of the sensor string with the first location still wetted and silence/acknowledge the detection/location alarm and clear the alarm queue.
        d) Wet the sensor cable in three additional locations between the first and second leak location with each detection/location alarm being silenced/acknowledged and the alarm queue cleared with all prior leak locations still wetted.

    4) Prepare and submit a report verifying leak location and detection accuracy for each event. Provide a history print out of the test results from the panel. Submit TDR traces for each test run to allow verification of wet locations.
g. Field Technical Assistance. The contractor will provide manufacturer's technical assistance for contractor, training, installation inspection, start up and owner operating and maintenance training. Contractor is to follow the manufacturer’s instructions for installation. A time-domain reflectometry graph of the cable installation shall be provided at time of owner training.

2.10 LABELING AND IDENTIFICATION

A. Detectable Underground-Line Warning Tape: Acid- and alkali-resistant, polyester encased B-721 aluminum foil warning tape manufactured for marking and identifying underground utilities, 2 inches (50.8 mm) wide and 5 mils (0.127 mm) thick, continuously inscribed with sub-surface black lettering on color field noted below, with a description of the utility.

1. Yellow: CAUTION FUEL OIL LINE BELOW

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for fuel-oil piping system to verify actual locations of piping connections before equipment installation.

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

3.2 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.

B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.4 INSTALLATION - GENERAL

A. Install equipment in locations shown on the Contract Drawings, in accordance with manufacturer's installation procedures.

B. Field install all electrical devices provided under this Section.

C. Verify that electrical wiring installation is in accordance with Engineer-approved manufacturer's submittal and in accordance with installation requirements of Division 16.

D. Coordinate all Work to ensure that the installation of the equipment is not in conflict with the work performed under other Sections.

3.5 OUTDOOR PIPING INSTALLATION

A. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer. Review protective coating damage with Architect prior to repair.
3. Replace pipe having damaged PE coating with new pipe.

B. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump.

C. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.

D. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquid-tight joints.

E. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.

F. Install fittings for changes in direction in rigid pipe.

G. Install system components with pressure rating equal to or greater than system operating pressure.

H. Install pressure gage on suction and discharge from each pump. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.6 INDOOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Verify final equipment locations for roughing-in.

H. Comply with requirements for equipment specifications in Division 22 and Division 23 Sections for roughing-in requirements.

I. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.

J. Prohibited Locations:

1. Do not install fuel-oil piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
2. Do not install fuel-oil piping in solid walls or partitions.

K. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

L. Connect branch piping from top or side of horizontal piping.

M. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.

N. Do not use fuel-oil piping as grounding electrode.

O. Install basket strainer on inlet side of fuel-oil pump.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.7 VALVE INSTALLATION

A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliances and pumps.

B. Install valves in accessible locations.

C. Protect valves from physical damage.

D. Install metal tag attached with metal chain indicating fuel-oil piping systems.

E. Identify valves as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

F. Install oil safety valves at inlet of each oil-fired appliance.

G. Install pressure relief valves in distribution piping between the supply and return lines.

H. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.

I. Install manual air vents at high points in fuel-oil piping.

J. Install emergency shutoff valves at dispensers.

3.8 SPECIALTY VALVES, VENTS AND VACUUM BREAKERS

A. Install oil safety (lever gate or fusomatic) valves at inlet of each oil-fired appliance, fuel pump set, filtration unit, and inside generator room as close as possible to entrance of pipe.

B. Install pressure relief valves between pump discharge and downstream isolation valves and in distribution piping systems upstream of valves located in return lines.

C. Install manual air vents at high points in fuel-oil piping.

D. Install vacuum breakers on return lines of header fuel oil systems to prevent siphoning of header. Pipe vacuum breaker to vented 55-gallon collection drum.

3.9 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Bevel plain ends of steel pipe.
2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

G. Flared Joints: Comply with SAE J513. Tighten finger tight, then use wrench according to fitting manufacturer's written recommendations. Do not overtighten.

H. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.10 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1-1/4 and Smaller: Maximum span, 84 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
4. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2 inch.
5. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2 inch.
6. NPS 4: Maximum span, 13 feet; minimum rod size, 5/8 inch.

C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.11 FUEL-OIL PUMP INSTALLATION

A. Transfer Pumps:

1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
2. Set pumps on and anchor to concrete base.

B. Install two-piece, full-port ball valves at suction and discharge of pumps and pumpsets.

C. Install suction piping with minimum fittings and change of direction.

D. Install suction line, with foot valve, at one end of storage tank, 4 inches from the bottom of tank.

E. Install return line at the opposite end of storage tank from suction line.

F. For standalone pumps install vacuum and pressure gage, upstream and downstream respectively, at each pump to measure the differential pressure across the pump. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.12 FUEL MAINTENANCE SYSTEM INSTALLATION

A. Install two-piece, full-port ball valves at inlet and outlet of fuel oil maintenance system.

B. Install suction line, with foot valve, at one end of storage tank, 2 inches from the bottom of tank.

C. Install return line at the opposite end of storage tank from suction line.

3.13 LIQUID-LEVEL GAGE SYSTEM INSTALLATION

A. Contractor must adhere strictly manufacturer's installation procedures. Gauge manufacturer startup and calibration shall be included for the tank gauging system. The contractor shall not waive this requirement.

B. A letter from the tank gauge system manufacturer shall be provided to the Engineer stating that the system was checked out and calibrated by a factory trained representative and that all components are in working order.

3.14 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

A. Contractor must adhere strictly manufacturer's installation procedures. Manufacturer startup and calibration shall be included for the leak detection system. The contractor shall not waive this requirement.

1. Double-Wall, Fuel-Oil Storage Tanks: Install probes in interstitial space.
2. Single-Wall, Fuel-Oil Storage Tanks: Install probes as indicated in tank room or rupture basin.
3. Double-Containment Fuel-Oil Piping: Install leak-detection sensor probes in fuel-oil storage tank containment sumps and at low points in piping
4. Tank vaults: Install sensors as shown drawings.

B. A letter from the leak detection system manufacturer shall be provided to the Engineer stating that the system was checked out and calibrated by a factory trained representative and that all components are in working order.

3.15 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.

C. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

D. Connect piping to equipment with ball valve and union. Install union between valve and equipment.

E. Install flexible piping connectors at final connection to burners or oil-fired appliances that must be moved for maintenance access.

3.16 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, and signs are specified in Division 23 Section "Identification for HVAC Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, service meter, and earthquake valve.

1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Detectable Underground-Line Warning Tape: Bury underground tape no less than 12 inches above line and 4 inches to 6 inches below surface for maximum detectability. Align tape parallel to centerline of pipe.

1. Piping: Over underground fuel-oil distribution piping.
2. Fuel-Oil Storage Tanks: Over edges of each UST.

3.17 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig , 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete" or Division 03 Section Miscellaneous Cast-in-Place Concrete**."**

3.18 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Tanks (Field Erected): Minimum hydrostatic test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:

a. Single-Wall Tanks: Minimum 3-psig and maximum 5 psig.
b. Double-Wall Tanks:

1) Inner Tanks: Minimum 3-psig and maximum 5psig
2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum. Factory Installed Gauge

c. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10-psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
d. Maintain the test pressure for one hour.

2. Piping: Minimum hydrostatic test-pressures measured at highest point in system:

a. Fuel-Oil Distribution Piping: Hydrostatically tested to a minimum of 50 PSIG or 1½ times the operating pressure, whichever is greater for a minimum of 1-hour.
b. Fuel-Oil, Double-Containment Piping:

1) Carrier Pipe: Hydrostatically tested to a minimum of 50 PSIG or 1½ times the operating pressure, whichever is greater for a minimum of 1-hour.
2) Containment Conduit: Pneumatically tested at 15 psig for minimum of 1-hour.

c. Suction Piping: Minimum 20-in. Hg for minimum 1-hour.
d. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10-psig.

3. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.

4. Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than four different depths while filling tank and checking against gage indication.
5. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
6. Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks.
7. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
8. Test day tank level control sequence and alarms
9. Bleed air from fuel-oil piping using manual air vents.

D. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections, repair and retest per code.

E. Prepare test and inspection reports.

3.19 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fuel oil pumps, liquid-level gage systems, leak-detection and monitoring systems, and related controls and instruments.

3.20 OUTDOOR PIPING SCHEDULE

A. Underground fuel-oil piping shall be the following. Size indicated is carrier-pipe size.

1. Rigid, double-containment piping.

B. Underground fuel-oil-tank fill and vent piping shall be the following:

1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints. Coat pipe and fittings with protective coating for steel piping.
2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints. Coat pipe and fittings with protective coating for steel piping.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

D. Aboveground fuel-oil piping shall be the following:

1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

3.21 INDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping shall be the following:

1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.

3.22 ABOVEGROUND MANUAL FUEL-OIL SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe NPS 2 and smaller shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Distribution piping valves for pipe NPS 2-1/2 and larger shall be the following:

1. Two-piece, full -port, bronze ball valves with bronze trim.

C. Valves in branch piping for single appliance shall be the following:

1. Two-piece, port, bronze ball valves with bronze trim.

END OF SECTION 231000

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SECTION 231113 – FACILITY FUEL OIL PIPING

SECTION 231213 FUEL TANK REMOVAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials and equipment required to perform the work called for in this Section of the Specifications; including, but not necessarily limited to the following:

1. Provide and install all OSHA excavation protection.
2. Pump out residual fuel oil, sludge, and water.
3. Removal of an existing 5,000 gallon steel fuel tank, fuel piping, vent piping, wiring, conduits, controls, etc.
4. Site remediation.

B. Underground Fuel Tank Cleaning and Disposal:

1. Removal and proper disposal of remaining residual fuel oil, sludge, and water.
2. Evacuation of combustible vapors.
3. Tank cleaning.
4. Disassembling of tank.
5. Certification for proper disposal of tank.

C. Underground Fuel Piping Removal

1. Remove existing supply and return piping between the existing tank and the existing building foundation wall, as shown on the Drawings.

D. Excavation of Soil Pollution:

1. Polluted soil disposal.
2. Certification for proper disposal of polluted soil.

E. Report:

1. Waste manifest describing in detail the quantities of fuel oil, sludge, and water removed from the tank prior to removal.
2. Written disposal report documenting that the tank and residual fuel oil, sludge, and water was properly recycled or disposed of according to federal, state, and local regulations.

1.2 QUALITY ASSURANCE:

A. Underground fuel tank removal and disposal shall comply with the following:

1. Department of Energy and Environmental Protection Section §22a-449(d)-1 of the Regulations of Connecticut State Agencies and all other tank closure guidelines.
2. OSHA Standards 29 CFR Part 1910 and 1926.1128.
3. Tank removal method must comply with the Connecticut State Fire Prevention Code.

1.3 WORK BY OTHERS

A. Owner/Engineer will provide sampling and testing services for tank closure and for soil and groundwater contamination in the event that soil and groundwater contamination is discovered.

B. Contractor shall notify Owner/Engineer seven days in advance of tank removal. Contractor shall notify Fire Marshall at least 48 hours in advance of tank removal.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Prior to removal of the tank, Contractor will be responsible for the removal of all residual heating oil, sludge, and water remaining in the tank and in the product suction and return piping.

B. Contractor shall remove the existing tank level sensing equipment.

C. Remove underground storage tank, product and vent piping, TLS wiring, and complete all associated work, including soil removal as specified and indicated on the drawings. The execution of this work may require some hand digging. Carefully contain any spills.

D. Excavate and stage soil on 6-mil plastic in the lawn areas, cover with plastic and surround with hay bales for erosion control. The Owner will retain the services of an environmental professional to appropriately characterize the soil for reuse.

E. Provide construction fence and barricades around the work area for as long as necessary.

F. Restore the excavated area with new compacted gravel fill and topsoil as specified to a depth of three feet below the existing grades.

3.2 UNDERGROUND STORAGE TANK LIQUID REMOVAL

A. Contractor shall retain the services of a Connecticut Licensed Hazardous Waste Hauler to vacuum all residual fuel oil, sludge, and water from the tank for recycling / disposal prior to removing the tank from the ground.

B. Provide documentation of the liquid removal and its recycling / disposal in a final report to the Owner.

3.3 UNDERGROUND STORAGE TANK CLEANING AND DISPOSAL

A. Contractor shall notify the local Fire Marshal of the tank removal at least 48 hours in advance.

B. After removing all residual liquids, remove the tank from the ground, place it on level ground adjacent to removal location, and secure it prior to cleaning.

C. Collect, contain and remove all residuals using a Connecticut licensed Hazardous Waste Hauler or place all residuals in a United States Department of Transportation (DOT) approved type 17H, 200 L (55 gallon) capacity drum, for subsequent transporting and disposal by Contractor.

D. Remove tank to an approved disposal facility.

E. Obtain disposal facility receipts noting proper tank disposal.

3.4 REMOVED TANK AREA ASSESSMENT

A. Provide OSHA compliant excavation sloping to allow Owner/Engineer access to the tank grave in order to assess the site for evidence of a release and to allow for the safe collection of soil/water samples by Owner/Engineer or collect the soil samples using the excavator bucket at the Owner's/Engineer's direction.

3.5 CONTAMINATED SOIL

A. If an initial inspection of the tank grave excavation area shows that a release of fuel oil may have occurred, Contractor shall notify the Owner / Engineer as soon as possible. Contractor shall, at the direction of the Owner / Engineer segregate up to 24 tons of potentially contaminated soil as part of the base bid tank removal activities. Any volume difference between the tank and the tank boundary shall not exceed 24 tons of soil. Any work beyond this boundary shall be considered extra and shall be based on the unit pricing for Contaminated Soil Removal.

B. Contractor shall excavate contaminated soil at the direction of the Owner / Engineer.

C. Remove all contaminated soil from the site and transport the soil to a licensed disposal facility approved by the Owner / Engineer. The cost for all permits and approvals, including additional soil sampling and for disposal of the contaminated soil shall be included in the base bid.

3.6 UNDERGROUND FUEL PIPING REMOVAL

A. Carefully isolate, disconnect and drain existing supply and return fuel piping, located between the existing storage tank and the building.

B. Removal all traces of fuel prior to attempting to remove piping. Contain and clean up any spilled oil during fuel piping removal process.

END OF SECTION

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SECTION 231213 – FUEL TANK REMOVAL

SECTION 231213 - FUEL TANK REMOVAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, materials and equipment required to perform the work called for in this Section of the Specifications; including, but not necessarily limited to the following:

1. Provide and install all OSHA excavation protection.
2. Pump out residual fuel oil, sludge, and water.
3. Removal of an existing 5,000 gallon steel fuel tank, fuel piping, vent piping, wiring, conduits, controls, etc.
4. Site remediation.

B. Underground Fuel Tank Cleaning and Disposal:

1. Removal and proper disposal of remaining residual fuel oil, sludge, and water.
2. Evacuation of combustible vapors.
3. Tank cleaning.
4. Disassembling of tank.
5. Certification for proper disposal of tank.

C. Underground Fuel Piping Removal

1. Remove existing supply and return piping between the existing tank and the existing building foundation wall, as shown on the Drawings.

D. Excavation of Soil Pollution:

1. Polluted soil disposal.
2. Certification for proper disposal of polluted soil.

E. Report:

1. Waste manifest describing in detail the quantities of fuel oil, sludge, and water removed from the tank prior to removal.
2. Written disposal report documenting that the tank and residual fuel oil, sludge, and water was properly recycled or disposed of according to federal, state, and local regulations.

1.2 QUALITY ASSURANCE:

A. Underground fuel tank removal and disposal shall comply with the following:

1. Department of Energy and Environmental Protection Section §22a-449(d)-1 of the Regulations of Connecticut State Agencies and all other tank closure guidelines.
2. OSHA Standards 29 CFR Part 1910 and 1926.1128.
3. Tank removal method must comply with the Connecticut State Fire Prevention Code.

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A. Owner/Engineer will provide sampling and testing services for tank closure and for soil and groundwater contamination in the event that soil and groundwater contamination is discovered.

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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

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B. Contractor shall remove the existing tank level sensing equipment.

C. Remove underground storage tank, product and vent piping, TLS wiring, and complete all associated work, including soil removal as specified and indicated on the drawings. The execution of this work may require some hand digging. Carefully contain any spills.

D. Excavate and stage soil on 6-mil plastic in the lawn areas, cover with plastic and surround with hay bales for erosion control. The Owner will retain the services of an environmental professional to appropriately characterize the soil for reuse.

E. Provide construction fence and barricades around the work area for as long as necessary.

F. Restore the excavated area with new compacted gravel fill and topsoil as specified to a depth of three feet below the existing grades.

3.2 UNDERGROUND STORAGE TANK LIQUID REMOVAL

A. Contractor shall retain the services of a Connecticut Licensed Hazardous Waste Hauler to vacuum all residual fuel oil, sludge, and water from the tank for recycling / disposal prior to removing the tank from the ground.

B. Provide documentation of the liquid removal and its recycling / disposal in a final report to the Owner.

3.3 UNDERGROUND STORAGE TANK CLEANING AND DISPOSAL

A. Contractor shall notify the local Fire Marshal of the tank removal at least 48 hours in advance.

B. After removing all residual liquids, remove the tank from the ground, place it on level ground adjacent to removal location, and secure it prior to cleaning.

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D. Remove tank to an approved disposal facility.

E. Obtain disposal facility receipts noting proper tank disposal.

3.4 REMOVED TANK AREA ASSESSMENT

A. Provide OSHA compliant excavation sloping to allow Owner/Engineer access to the tank grave in order to assess the site for evidence of a release and to allow for the safe collection of soil/water samples by Owner/Engineer or collect the soil samples using the excavator bucket at the Owner’s/Engineer’s direction.

3.5 CONTAMINATED SOIL:

A. If an initial inspection of the tank grave excavation area shows that a release of fuel oil may have occurred, Contractor shall notify the Owner / Engineer as soon as possible. Contractor shall, at the direction of the Owner / Engineer segregate up to 24 tons of potentially contaminated soil as part of the base bid tank removal activities. Any volume difference between the tank and the tank boundary shall not exceed 24 tons of soil. Any work beyond this boundary shall be considered extra and shall be based on the unit pricing for Contaminated Soil Removal.

B. Contractor shall excavate contaminated soil at the direction of the Owner / Engineer.

C. Remove all contaminated soil from the site and transport the soil to a licensed disposal facility approved by the Owner / Engineer. The cost for all permits and approvals, including additional soil sampling and for disposal of the contaminated soil shall be included in the base bid.

3.6 UNDERGROUND FUEL PIPING REMOVAL

A. Carefully isolate, disconnect and drain existing supply and return fuel piping, located between the existing storage tank and the building.

B. Removal all traces of fuel prior to attempting to remove piping. Contain and clean up any spilled oil during fuel piping removal process.

END OF SECTION

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SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL WORK

SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 REFERENCES

A. Refer to the GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and applicable parts of DIVISION 1 for other general requirements. These requirements may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall NOT be construed to reduce the requirements of those Divisions NOR to eliminate other requirements under those Divisions.

B. The requirements of this Section apply to ALL work specified in this Division, unless modified to be of higher quality or more stringent in another Section.

1.2 INTENT

A. The CONTRACT DOCUMENTS are inclusive of all Drawings and Specifications, both those specifically covering the work of this Division and those covering other subjects of work.

B. It is the intent of the Contract Documents to require finished work, tested and ready for operation.

C. It is not intended that Contract Documents show every pipe, wire, conduit, fitting and appurtenance; however, such parts as may be necessary to complete the systems in accordance with best trade practice and Code requirements and to Architect/Engineer's satisfaction shall be deemed to be included.

D. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. DO NOT SCALE THE DRAWINGS.

1.3 EXAMINATION OF SITE AND CONTRACT DOCUMENTS

A. Before submitting prices or beginning work, thoroughly examine the site and the Contract Documents.

B. No claim for extra compensation will be recognized if difficulties are encountered which would have been revealed by examination of site conditions and Contract Documents prior to executing Contract.

C. Where discrepancies occur within Contract Documents, notify Architect/Engineer, in writing, of discrepancy and request clarification. Until notified of Architect/Engineer's decision, include item or arrangement of better quality, greater quantity or higher cost in Contract price.

D. For material, device and equipment identified on Contract Drawings by manufacturer and/or model: Coordinate with Specification for ancillary requirements and include with furnished item.

E. Notify Architect/Engineer, in writing, of materials and apparatus believed to be omitted, inadequate or unsuitable, or in violation of laws, ordinances, rules or regulations of authorities having jurisdiction. In absence of such written notice, it is mutually agreed that bid price for work under each Section has included the cost of items required for acceptable satisfactory functioning of entire system.

1.4 DEFINITIONS

A. Where more than one material, item, or grade is listed in same paragraph, first one named is preferred choice.

B. The following terms are used in this Division and are defined as follows:

1. "Indicated", "shown", "noted", "scheduled", "specified": These terms are a cross-reference to graphics, notes or schedules on the Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in Contract Documents. NO limitation of location is intended except as specifically noted.
2. "Directed", "requested", "authorized", "selected", "required", "permitted": Where not otherwise explained, these terms mean "directed by the Architect/Engineer", "requested by the Architect/Engineer", etc. However, NO such implied meaning will be interpreted to extend the Architect/Engineer's responsibility into Contractor's area of construction supervision or means and methods.
3. "Provide": To furnish and install, ready for safe and regular operation the item, material or service indicated.
4. "Furnish": To purchase, acquire and deliver to the site, complete with related accessories.
5. "Install": To erect, mount and connect completely, by acceptable methods.
6. "Work": Labor, materials, equipment, apparatus, controls and accessories required for proper and complete installation.
7. “Finished Spaces”: Spaces other than the following:

    a. Mechanical and electrical equipment rooms.
    b. Furred spaces.
    c. Pipe and duct shafts.
    d. Unheated spaces immediately below roof.
    e. Spaces above ceilings.
    f. Unexcavated spaces.
    g. Crawl spaces.

h. Tunnels.

8. “Exposed”, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical or electrical equipment rooms.
9. “Exposed”, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
10. “Concealed”, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in shafts.
11. “Concealed”, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated structures.
12. "Acceptable equivalent" or "Equal": Of weight, size, design, capacity and efficiency to meet requirements specified and shown, and of acceptable manufacture, as determined in the opinion of the Architect/Engineer.
13. "Acceptable": Acceptable, as determined in the opinion of the Architect/Engineer.
14. "Contractor": General Contractor, Trade Contractor, sub-Contractor, or Construction Manager.
15. "Named" Product: Manufacturer's name for product, as recorded in published documents of latest issue as of date of Contract Documents. Obtain Architect/Engineer's permission before using products of later or earlier model.

1.5 STANDARDS

A. Standards, specifications and tests of following technical societies, organizations and governmental bodies, as referenced in Contract Documents, are hereby made part of Contract Documents.

1. ANSI: American National Standards Institute
2. ASTM: American Society for Testing and Materials
3. EPA: Environmental Protection Agency
4. FSSC: Federal Specification
5. IRI: Industrial Risk Insurers
6. ISO: Insurance Services Office
7. NBS: National Bureau of Standards
8. NEC: National Electrical Code.
9. NEMA: National Electrical Manufacturers Association
10. NETA: International Electrical Testing Association
11. NFPA: National Fire Protection Association
12. NSC: National Safety Council
13. OSHA: Occupational Safety and Health Administration
14. UL: Underwriters Laboratories
15. NRTL: Nationally Recognized Testing Laboratory (3rd Party)
16. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers
17. ICC: International Code Council
18. IES/IESNA: Illuminating Engineering Society of North America
19. IEEE: The Institute of Electrical & Electronics Engineering

20. BICSI: Building Industry Consulting Services International
21. INETA/NETA: InterNational Electrical Testing Association
22. NECA: National Electrical Contractors Association
23. CODE: Codes and regulations of the Federal, State and local governments and of utility companies having jurisdiction, as appropriate.

Use of singular or plural reference form in the Contract Documents shall not be construed to limit number of units required. Specifications are intended to define quality and performance characteristics; quantity of units supplied shall be as needed to meet requirements as specified and at a minimum, as shown on Contract Documents.

1.6 PERMITS, LAWS, ORDINANCES AND CODES

A. Contractor shall obtain and pay for permits, inspections, licenses and certificates required for work under this Division.

B. Complete Utility connections as indicated or needed, extension to Project, metering as required, and connection to building systems, including:

1. Apply for all services and pay for all fees, assessments and charges of the Utility for each connection, all in a timely manner and according to the Project Schedule.
2. Provide and install all metering equipment and accessories as required by Utility. Install entire service in accordance with the Utility's requirements or other applicable regulation.
3. Coordinate with Utility to determine scope of work provided by Utility and the part provided by Contractor so that a complete Utility connection is made.
4. Schedule all work required by utility companies in order to maintain project schedule.

C. Contractor shall pay utility company charges associated with work of this Division.

D. Contractor shall comply with laws, ordinances, rules and regulations of Local, State and Federal authorities having jurisdiction; and shall comply with rules and regulations of National Board of Fire Underwriters, National Electrical Code and local utility companies.

E. Contract Documents shall govern whenever they are more stringent than Code requirements.

1.7 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun, prepare coordination drawings showing relationship of work among all trades.

B. Submit completed and signed coordination drawings to the Architect/Engineer for review.

C. Coordination drawings are for use by Contractors and Architect/Engineer during construction and are not replacements for shop, as built, or record drawings required elsewhere in the Contract Documents

1.8 SHOP DRAWING SUBMITTALS

A. General

1. Prior to submission of specific shop drawings, submit for review a preliminary list of intended or proposed manufacturers for all items for which shop drawings are required.
2. Submit through contractual channels for review.
3. Number of copies as directed in DIVISION 1.

B. Shop Drawings – Electronic: Identify and incorporate information in each submittal as follows:

1. Electronic Submittals: Submit in accordance with requirements of Project website submittals procedures.
2. Assemble complete submittal package into a single submittal, incorporating submittal requirements of a single Specification Section.
3. Metadata: Include the following information as keywords in the electronic submittal metadata:
   a. Project name.
   b. Number and title of appropriate Specification Section.
   c. Manufacturer name.
   d. Product name.
4. Shop drawings shall include the following information:

   a. Descriptive and product data necessary to verify compliance with Contract Documents.
   b. Manufacturer’s specifications including materials of construction, metal gauge, thickness, and finish.
   c. Certified dimensional drawings including clearances required for maintenance or access.
   d. Performance data, ratings, operating characteristics, and operating limits.
   e. Operating points on curves.
   f. Electrical ratings and characteristics.
   g. Wiring and control diagrams, where applicable.
   h. Certifications requested, including UL label or listing.
   i. List of accessories which are required but are NOT being furnished by the product manufacturer or are NOT being provided by this Section. Identify the Section(s) by which the accessories are being furnished or provided.

5. Clearly mark submittals with the following:

   a. Where equipment is specified, as follows:

      1) Specifications: Section and paragraph.
      2) Drawings: Drawing number, schedule, note, and detail, as required.

   b. Equipment or fixture identification corresponding to that used in Contract Documents.

c. Accessories and special or non-standard features and materials, which are being provided.

6. The selection and intention to use a product specified by name shall NOT excuse the need for timely submission of shop drawings for that product.
7. For samples submitted in lieu of shop drawings, submit as follows:

a. Submit samples in duplicate.
b. Clearly identify the samples.
c. All samples that are not accepted will be returned.
d. For samples that are approved, one sample will be returned and one sample will be kept by the Engineer.

8. Upon completion of shop drawing review, shop drawings will be returned, marked with one of the following notations: Furnish as Submitted, Furnish as Corrected, Revise and Resubmit, Rejected, or Submit Specified Item. Use only products whose shop drawings are marked Furnish as Submitted or Furnish as Corrected.

C. Options: Identify options requiring selection by Architect.

D. Deviations and Additional Information: Include relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal.

E. Resubmittals: Make resubmittals in same manner as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Architect's action stamp.

F. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

G. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

H. Material Safety Data Sheets (MSDS):

1. If required by the Owner, submit MSDSs directly to the Owner; do not submit to Architect.
   a. Architect will not review submittals that include MSDSs and will return without review.
   b. Do not include MSDSs and remove MSDS sheets attached to product data or included with other submittals that require submission to the Architect.

I. Other Submittals

1. Refer to Sections of this Division for additional submittal requirements relating to specific equipment or systems.

J. Submission of shop drawings of an unnamed manufacture or shop drawings at variance with the Contract Documents is NOT a proper request for substitution.

K. Repeat submission of products without addressing all comments from prior review will be returned to the Contractor without review for correction. Note:

1. Contractor may be liable for additional efforts expended by the Architect/Engineer
2. Contractor WILL be liable for impact to project schedule.

L. Test reports are to be submitted to Architect/Engineer for review prior to acceptance of equipment or systems for beneficial use.

1.9 PRODUCT SELECTION

A. Options for selecting products are limited by Contract Document requirements and governing regulations and are NOT controlled by industry traditions or procedures experienced by Contractor on previous construction projects. Required procedures include, but are NOT necessarily limited to, following specifying methods in Contract Documents:

1. Single Product Manufacturer Named: Provide product indicated.
2. Two or More Manufacturers' Products Named: Provide one of the named products, at Contractor's option, but excluding products which do NOT comply with requirements.
3. "Acceptable equivalent" or "Or Equal": Where named products are accompanied by this term or words of similar effect, provide one of named products or propose substitute product according to paragraph SUBSTITUTIONS.
4. Standards, Codes and Regulations: Where specification requires only compliance with a standard, code or regulation, Contractor may select any product which complies with requirements of that standard, code or regulation.
5. Performance Requirements: Provide products which comply with specific performances indicated and which are recommended by manufacturer (in published product literature or by individual certification) for application intended. Overall performance of product is implied where product is specified with only certain specific performance requirements.
6. Prescriptive Requirements: Provide products which have been produced in accordance with prescriptive requirements using specified materials and components, and complying with specified requirements for fabricating, finishing, testing and other manufacturing processes.
7. Visual Matching: Where matching with an established material is required, Architect/Engineer's judgment of whether proposed product matches established material shall be final.
8. "Color as Selected by Architect": Unless otherwise noted, where specified product requirements include "color as selected by Architect" or words of similar effect, the

selection of manufacturer and basic product complying with Contract Documents is Contractor's option and subsequent selection of color is Architect's option.

B. Inclusion by name, of more than one manufacturer or fabricator, does NOT necessarily imply acceptability of standard products of those named. All manufacturers, named or proposed, shall conform, with modification by manufacturer as necessary, to criteria established by Contract Documents for performance, efficiency, materials and special accessories.

1.10 SUBSTITUTIONS

A. Contractor's request for substitution may be submitted only after award of Contract. Requests shall be in writing and presented through appropriate contractual channels.

B. Substitution Request to include the following:

1. Detailed comparison of significant differences in quality, construction, performance, features, options, and appearance between specified item and proposed substitution. Citation, where applicable, to where a specified requirement is located in the Contract Documents is to be provided.
2. Statement of effect on construction time, coordination with other affected work, and cost of work.
3. Contractor's statement to the effect that proposed substitution will result in overall work equal to, or better than, work originally intended.

C. Substitution requests will be considered based on all of the following:

1. If extensive revisions to Contract Documents are NOT required
2. If changes are in keeping with general intent of Contract Documents
3. If submitted in timely and proper manner, fully documented
4. If one or more of following conditions is satisfied; all as judged by Architect/Engineer:

a. Where request is directly related to "acceptable equivalent" clause, "or equal" clause or words of similar effect in Contract Documents.
b. Where specified product, material or method CANNOT be provided within Contract Time; but NOT as a result of Contractor's failure to pursue the work promptly or properly coordinate Contractor’s efforts.
c. Where substantial advantage is offered Owner; in terms of cost, time, energy conservation or other valuable considerations; after deducting offsetting responsibilities that Owner may be required to bear, including additional compensation to Architect/Engineer for redesign and evaluation services, increased cost of other work by Owner or separate contractors, and similar considerations.

D. The burden is upon the Contractor, supplier and manufacturer to satisfy Architect/Engineer that:

1. Proposed substitute is equal to, or superior to, the item specified.

2. Intent of the Contract Documents, including required performance, capacity, efficiency, quality, durability, safety, function, appearance, space clearances and delivery date, will be equaled or bettered.

E. Submission of shop drawings of unspecified manufacture or shop drawings at variance with the Contract Documents is NOT a proper request for substitution.

F. Changes in work of other trades, such as structural supports, which are required as a result of substitution and the associated costs for such changes shall be the complete responsibility of Contractor proposing substitution. Except as noted in subparagraph 1.10.C.4 (a) above, there shall be NO additional expense to the Owner.

G. Substitution requests that require the Architect/Engineer to expend additional efforts for review, investigation, verification, or similar activities, will require the Contractor to compensate the Architect/Engineer at the rate of $120/hr if:

1. Architect/Engineer is not familiar with the proposed manufacturer or the proposed product from that manufacturer
2. Architect/Engineer needs to investigate proposed product, attend presentations, confer with other professionals, contact references, or similar activities that would not otherwise have been required if one of the named products was proposed.
3. Architect/Engineer must travel to the manufacturer's facilities or a representative installation of the proposed product to review, confirm, or assess product characteristics or directly communicate with manufacturer's representatives on technical or product support subjects.

1.11 SAMPLES

A. Submit samples where required or referenced elsewhere in this Division of work.

B. Where in the opinion of the Architect/Engineer, a sample is required to clarify the acceptable characteristics of a material or product, additional samples may be required.

1.12 RECORD DRAWINGS

A. Furnish and keep on the job at all times, a minimum of one complete and separate set of Contract Documents for the purpose of tracking installation of the work.

B. As work progresses, record changes, revisions and additions to the work clearly, neatly, accurately and promptly. Items to be indicated include but are not limited to:

1. Dimensional change of equipment or material.
2. Revision to Drawing Detail.
3. Location and depth of underground utilities, structures, equipment, tanks, etc - referenced from project benchmarks.

4. Location and depth of underslab utilities and distribution.
5. Actual routing of distribution systems.
6. Revision to power or control wire circuiting/source.
7. Actual equipment location.
8. Location of concealed distribution work such as pipes, conduits, ducts, etc.
9. Location of concealed work and access panels, where access for maintenance or service is required.
10. Changes made by Change Order.
11. Details not on original Contract Drawing, but used for installation of the work.
12. Information on concealed elements which would be difficult to identify or measure later.

C. Indicate daily progress on these prints by coloring in the various lines, fixtures, apparatus and associated appurtenances as they are erected.

D. Approval of requisition for payment for work installed will NOT be given unless supported by record prints as required above.

E. At the conclusion of work, prepare final record drawings reflecting all field recorded data, neatly transferred from documents used in the field to a clean paper set of the Original Contract Documents. Submit record drawings for review by Architect/Engineer. After review and acceptance, the Contractor will be furnished with an electronic set of the original contract documents to be edited to reflect modifications and field data as reported on record drawings. Electronic copy of final “as-built” contract documents to be provided to the Owner in a format agreed upon at the commencement of work.

F. Coordination Drawings are to be updated, reflecting installation of work that differs from that presented on the Coordination Drawings which were signed off at the start of work. All trades will review and sign off on these documents as accurate. Electronic copy of final “as-built” coordination drawings to be provided to the Owner in a format agreed upon at the commencement of work.

G. Refer to DIVISION 1, GENERAL CONDITIONS and SUPPLEMENTARY CONDITIONS for further requirements.

1.13 OPERATING AND MAINTENANCE MANUALS

A. Submit for review operating and maintenance (O&M) manuals for each system or piece of equipment. Applicable content, as generated, is to be collected continuously during the construction process and maintained in a DRAFT manual format for review by the Architect/Engineer at any time.

B. Completed manual will be reviewed by the Architect/Engineer and modifications made as identified, before distribution or use. Acceptance will be required prior to scheduling of Owner Training and Instructions.

C. Required modifications identified during Training and Instruction activities are to be made before final Manual is delivered to the Owner.

D. Refer to DIVISION 1 for additional requirements and procedures relating to O&M manuals.

E. Operating and maintenance manual(s) will be organized with the following fundamental content:

1. Table of Contents and Index

2. Project Information

   a. Contractor name, address, contact information, and primary contact individual specific to this project
   b. Sub-contractor names, responsibility, address, contact information, and primary contact individual specific to this project.
   c. Summary description of project scope and period of time work was executed.

3. Guarantees and Warranties

   a. Documentation describing covered work/materials, effective coverage dates, and terms/conditions
   b. Contact information for initiating a claim and responsible party

4. Each Major Building System

   a. Supplier information including

      1) Technical Support contact
      2) Source of parts / replacement units
      3) Chain of purchase (Supply house, manufacturer’s sales vendor, sub-contractor, etc), including Original order number/identification for tracking purposes

   b. Operating Instructions

      1) Prepared specific for this project

         a) System Description
         b) Operating parameters
         c) Adjustable settings and purpose
         d) Warnings and cautions
         e) Sequence of Operations and Control Diagrams

      2) Description of training and instruction provided to Owner including:

         a) Date(s) of instruction/training

b) Agenda
c) Attendee list

c. Maintenance Instructions

1) Prepared specific for this project

a) Preventative maintenance schedule
b) Summary of consumable materials / regularly replaced elements
c) Recommended stocking materials and specialized tools or equipment necessary to perform regular and preventative maintenance
d) Maintenance contracts secured under this project, or separately contracted for through this provider.

d. Commissioning and Test Reports

1) Documentation of all inspection and testing activities performed with associated reports and corrective measures undertaken (if applicable).
2) Factory test reports
3) Certification letters for equipment manufacturers attesting to the complete and satisfactory installation and operation of systems/products.
4) Seismic inspection and certification
5) Special inspections
6) Sign off by Authorities Having Jurisdiction

e. Parts / Material List

1) Bill of materials for each system or piece of equipment

f. Product Literature

1) Copy of shop drawings reflecting final acceptance by Architect/Engineer, with modifications made reflecting changes to the installed work which is not represented accurately.

g. Manufacturer’s Operation & Maintenance Literature

1) Materials provided with equipment/products shipped for use on project
2) Supplementary materials which are required to provide the Owner with a complete representation of manufacturer’s instructions and recommendations.

F. In addition to the above, the following Content is to be included in the Operation & Maintenance Manual(s)

1. Copy of All Panelboard, Power Panel, Distribution Panel, and Switchboard Directory

2. Copy of final Short Circuit Coordination and Arc Flash Study. Copy of all PPE labels, electronic copy and hard copy in color
3. Copy of all electrical testing reports for cables, breakers, distribution system equipment, generation equipment, control and transfer equipment when such is included in project scope.
4. Copy of all testing reports for life safety systems as witness and signed off by Authority Having Jurisdiction.
5. Other data, as required under pertinent Sections of these Specifications.

1.14 GUARANTEE

A. Furnish standard manufacturers' guarantees for work under this Division. Such guarantees shall be in addition to, and NOT in lieu of, other liabilities under the law or by other provisions of the Contract Documents.

B. Materials, equipment and workmanship shall carry the standard warranty against defects in material and workmanship. Failure which may develop due to defective or improper material, equipment, workmanship or design shall be made good, forthwith, by and at the expense of the Contractor, including damage done to areas, materials and other systems resulting from this failure.

C. Guarantee that all elements of the systems are of sufficient capacity to meet the specified performance requirements as set forth in Contract Documents.

D. Upon receipt of notice from Owner of a failure of system(s) or component(s) during the guarantee period, replace affected components within reasonable time period at no additional cost.

E. Guarantee period shall extend for one year from Date of Substantial Completion.

F. Before final request for payment, furnish written guarantee covering above requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Products shall be undamaged and unused at time of installation and shall be complete with accessories, trim, finish, safety guards and other devices and details needed for complete installation and for intended use.

B. Where available, products shall be standard products of types which have been produced and used previously and successfully on other projects and in similar applications.

C. Labels and Stamps

1. Locate labels and stamps required to be observed after installation on accessible surfaces. In occupied spaces, select locations that are not conspicuous.
2. Locate labels and stamps not required to be observed after installation on concealed surfaces.

PART 3 - EXECUTION

3.1 ARRANGEMENT OF WORK

A. Consult Architectural Contract Drawings and Details for exact locations of fixtures and equipment. If exact location is not given, obtain information from Architect/Engineer. Verify measurements in field. Base measurements on Architect/Engineer's established benchmarks.

B. Install all conduits concealed from view and protected from physical contact by building occupants unless otherwise indicated or when routed in equipment, rooms and service areas.

C. Install work as closely as possible to layouts shown on Contract Drawings. Modify work as necessary to:

1. Provide maximum possible headroom and space clearance on each side.
2. Provide adequate clearance and ready access to all parts of the work, for inspection, operation, safe maintenance and repair, and code conformance.
3. Coordinate and arrange work to avoid conflicts with work of other trades, to avoid unnecessary cutting and patching, and as needed for satisfactory space conditions shown on coordination drawing submittals.
4. Where space appears inadequate, consult Architect/Engineer before proceeding with installation.

D. Coordinate installation of required supporting devices.

E. Set sleeves in cast-in-place concrete for services that will need to pass through concrete. Coring of installed concrete is not intended and the Contractor will be responsible for determining the impact on structural integrity, certifying that there will be no impact, and any remedial work required to accommodate impact from coring.

F. Work shall present a neat coordinated appearance.

3.2 COORDINATION

A. Examine Contract Documents and coordinate with Contractor and other trades as necessary to facilitate the progress of the work.

B. Each trade shall keep Contractor and other trades fully informed as to shape, size, and locations of openings, chases, equipment, panels, access doors, sleeves, inserts and anchor bolts required; whether temporary or permanent. Coordinate sizes, depths, fill and bedding requirements with

excavation trades. Give sufficient advance notice so that coordination may be completed in advance. If information is not furnished in proper and timely fashion, the trade involved shall do own cutting and patching or have same done by Contractor, without additional cost to Owner.

C. Coordinate size and location of concrete bases with DIVISION 3 and the following:

1. Floor Drains and underslab utilities
2. Dimensional requirements for embedded anchors as necessary for support, vibration isolation, and seismic restraint.
3. Access and walkway requirements
4. Work of other trades

D. Particular emphasis is placed on timely installation of major apparatus and furnishing of other trades and Contractor with relevant information.

E. Do NOT install a system until critical components of system and related systems have been coordinated and applicable shop drawings have been accepted.

3.3 WORKMANSHIP

A. Work covered under this Division shall be constructed and finished in every respect in a workmanlike and substantial manner.

B. Equipment and materials shall be new, of first quality, selected and arranged to fit properly into spaces indicated.

C. Obtain detailed information from manufacturer as to proper methods for installation and connections. This includes such tests as equipment manufacturer recommends. Where documentation regarding installation is NOT obtainable, work shall be installed in accordance with best trade practice.

1. Unless specifically indicated otherwise on Contract Documents, equipment and materials shall be installed in accordance with manufacturer's recommendations.
2. Notify Architect/Engineer of conflicts between manufacturer's recommendations and Contract Documents requirements, and request clarification before proceeding with installation.

D. Where equipment, piping, ductwork, conduit, etc. is exposed, color of finish or paint shall be as selected by Architect/Engineer.

3.4 OPERATION OF SERVICES AND UTILITIES

A. During the construction period and until finally inspected, tested and accepted, maintain new services and utilities.

B. Shutdown of existing services and utilities shall, without exception, be coordinated with the proper utility and with the Owner as to date, time of day, and duration.

1. Notify Architect/Engineer and Owner of estimated duration of shutdown period at least ten days in advance of date when shutdown is proposed. Approval of shutdown shall be obtained from proper utility and Owner, before any service is interrupted.
2. Work during shutdown period shall be arranged for continuous performance, including overtime if required, to ensure that existing operating services will be shut down only for time actually necessary to complete connections.

3.5 PROTECTION

A. Contractor shall be responsible for work and equipment until fully inspected, tested and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material or damaging water.

B. Equipment shall be protected against damage while in storage either on or off the construction site. The equipment shall be stored in a dry environment with temperature and controlled to within ranges specified by the manufacturer. Space heaters shall be installed and energized when required to control humidity. Store light sensitive materials where not subjected to direct sunlight.

C. Protect work and material of other trades from damage that might be caused by work of this and other Divisions and correct damage thus caused.

D. Maintain protective measures used for transport of equipment or materials to project site until ready to set and connect utilities and related work. If protective covers need to be removed for inspection or coordination of work, repair or replace to equivalent.

3.6 IDENTIFICATION

A. Distribution systems such as pipes, tubing, conduits, sheet metal, insulation, etc. shall have following information clearly printed on the material: manufacturer's name, material grade, gauge, thickness, type, and data to identify required methods of attachment; as applicable. Unmarked material shall NOT be used.

B. Permanent nameplates shall be provided on each piece of service-connected, power-operated, or distribution equipment, on easily accessible surface. Nameplate shall include product name, model number, serial number, capacity, speed, ratings, and similar essential operating data.

1. Manufacturer's nameplate, name, trademark and address shall be attached permanently to equipment and material furnished. Nameplate showing distributor or Contractor will NOT be permitted.
2. Unless otherwise specified or requested, letters and numbers shall be 1/2” high.

3. Attach nameplates with screws or rivets. Wherever covers of adjacent units are interchangeable, attach nameplates to wall or backboard rather than covers.

C. Unless specified elsewhere in this Section, labels shall be provided to indicate equipment according to designations used in Contract Documents. Label shall be plastic nameplate with letters and numbers 1-1/2" high. Furnish directory indicating number, location and use of each item. After finish painting is completed, apply identification label where it will be readily visible from normal operating position on floor.

3.7 LUBRICATION

A. Equipment shall be furnished and installed so that lubrication points are conveniently and readily accessible for maintenance. Make these provisions by whatever means is appropriate: extended fittings, access doors, equipment location, etc.

B. No equipment shall be operated for temporary service or for testing purposes without proper lubrication. Items requiring lubrication shall be left freshly and fully lubricated at time of substantial completion.

C. Prior to substantial completion, deliver to Owner, along with itemized list: one complete new set of special lubrication devices required for servicing, such as grease guns, fittings and adapters.

3.8 ATTACHMENT OF SUPPORTS TO BUILDING STRUCTURE

A. Equipment shall be securely attached to building structure in acceptable manner. Attachments shall be of strong and durable nature as determined by Architect/Engineer.

B. Attachment of supports to roof decking is NOT permitted. Pipes, ducts, conduits, boxes, etc. must be supported from building structural framing (bar joist, beams, columns) or by supplementary members installed by the Contractor, spanning structural framing in a method acceptable to the structural engineer.

C. Cut, Fit and place miscellaneous metal supports for installation of work.

D. Field Welding: Comply with AWS D1.1 or other applicable standards

E. Refer to DIVISION 5 for material specification of supplemental members to be installed.

3.9 ACCESSIBILITY, ACCESS PANELS AND ACCESS DOORS

A. Locate equipment which must be serviced, including motor starters, switches, panels and junction boxes, in accessible locations if at all possible. For other locations, furnish access panels as described under DIVISION 1.

B. Access doors shall be located to conveniently serve intended purpose and shall be installed so that adjacent piping, equipment and structures do NOT render doors unusable.

C. Access doors are not required in removable panel ceilings if suitable identifying markers are provided to indicate access locations.

D. During project closeout, Contractor shall perform walk-through identifying and demonstrating access to equipment for service and/or replacement. Walk-through shall be arranged at times convenient for Engineer and Owner to attend.

1. Equipment with insufficient access shall be relocated or provided with additional access panels at no additional cost to Owner.
2. Trade responsible for access problem shall be responsible for costs of access modifications. In general, this shall be understood to be the trade installing the equipment. If access problem was caused by architectural layout changes which occurred subsequent to equipment installation, cost of access modifications shall be borne by trade responsible for architectural changes.

3.10 WATERPROOFING

A. Where work pierces waterproofing, including waterproof concrete and floor of a wet area, submit method of installation for review by the Architect/Engineer before work is done.

B. Provide necessary sleeves, caulking and flashing required to make openings waterproof. See DIVISION 7 on WATERPROOFING.

3.11 GROUTING

A. Mix and install grout for equipment base bearing surfaces, base plates, and anchors

3.12 BASES AND SUPPORTS

A. Unless noted otherwise, provide necessary supports, rails, framing, bases and piers required for equipment furnished or installed under this Division.

B. Unless otherwise indicated: floor-mounted equipment shall be mounted on concrete pads. Concrete and associated reinforcing materials shall be as specified in DIVISION 3, CONCRETE.

1. Pads shall be four-inch thick minimum. Pads for seismically supported equipment shall extend at least 6 inches beyond equipment footprint. Coordinate final extension requirements with approved seismic shop drawing calculations and details. All other pads shall NOT extend more than one inch beyond equipment footprint. Top edge of pads shall be chamfered.

2. Furnish dimensional and load information so that shop drawings for pads may be submitted and reviewed prior to pad installation.
3. Equipment shall be firmly grouted into concrete pads and anchor bolted.

C. Where mounted on the floor: Foundations, supports, pads, bases and piers shall be of the same finish quality as the adjacent flooring material.

D. Equipment supports shall be designed and constructed so that equipment will be capable of resisting both vertical and horizontal movement. Refer to Section VIBRATION AND SEISMIC CONTROLS in this Division.

3.13 PAINTING

A. Unless otherwise specified, materials furnished under this Division shall have prime coat and standard manufacturer's finish.

B. Finish painting of exposed work and equipment is covered under DIVISION 9.

C. Paint equipment and appurtenances in concealed and unfinished areas with one coat of rust-inhibiting paint or with an appropriate bitumastic protective product designed for the intended application. Asphalt paint is NOT acceptable. Items to be painted shall include, but not be limited to: non-insulated hangers, supports, piping, conduit, tanks and other ferrous metal work, which are concealed or inaccessible but not galvanized.

D. Special care shall be taken to avoid painting or spattering equipment nameplates.

E. Cooperate in identifying systems for painters. Refer to paragraph, IDENTIFICATION in this Section.

3.14 TESTS - GENERAL

A. Make final adjustments to equipment before testing. Manufacturer's authorized representative shall verify proper installation and adjustment prior to startup of major equipment; refer to paragraph, OPERATING AND MAINTENANCE MANUALS in this Section.

B. Furnish labor, materials, instruments, supplies and services necessary for testing required under this Division. Correct defects appearing during tests, and repeat tests until no defects are disclosed. Final tests shall be made in Architect/Engineer's presence.

C. Use true RMS ammeter to measure current, for equipment which may have harmonic (non-linear) load component.

D. Notify Owner, Architect and Engineer of testing schedule at least 48 hours in advance of tests.

E. Perform specified tests and tests required by legal authorities and by agencies having jurisdiction over this Work. Tests shall be performed to the satisfaction of legal authorities, agencies having jurisdiction, and Owner.

F. Each piece of equipment, including motors and controls, shall be operated continuously for minimum test period of one hour.

G. If manufacturer's startup services are specified under other Sections in this Division, furnish services of factory-trained service engineering representative to provide following. If manufacturer's startup services are not required, Contractor shall furnish following services.

1. Inspection of equipment/system installation.
2. Assistance in initial startup and adjustment of equipment; including necessary time to achieve proper installation and adjustments.
3. Instruction of Owner's staff; see paragraph, INSTRUCTIONS in this Section.

H. Upon completion of tests, demonstrate the following:

1. Equipment and systems are installed and operating in accordance with manufacturer's specifications and instructions and with Contract Documents.
2. Proper adjustment of equipment and systems.
3. Systems are properly cleaned and free of contaminants.
4. Systems are properly phase balanced.
5. Circuits and motorized equipment are equipped with proper overload protection and are not operating under overload.
6. Instruments are recording properly.

I. Refer to testing requirements in other Sections of this Division for addition work.

3.15 INSTRUCTIONS

A. Arrange for each installer of work requiring continuing maintenance or operation, to meet with Owner's personnel at project site and instruct them in the operation and maintenance. Include instruction by manufacturer's representatives where installers are not expert in the required procedures. Instruction periods for all trades shall be minimum of 8 hours total; refer to individual SECTIONS for further requirements.

B. Instructions include, but are not limited to, the following:

1. Review of Operation and Maintenance manuals, record documentation, tools, spare parts and materials, lubricants, fuels, identification system, control sequences, hazards, cleaning, and similar procedures and facilities.
2. Demonstration of the following:

a. Start up procedures
b. Shutdown procedures

c. Emergency operations
d. Noise/vibration control adjustments
e. Safety concerns and protective equipment
f. Economy/efficiency adjustments
g. Cleaning
h. Similar operations

3. Review of applicable guarantees and warranties.
4. Demonstration of procedures for routine maintenance, at the equipment involved, to ensure proper accessibility to components involved.

3.16 QUIET OPERATION

A. Equipment and material provided as part of the Work shall NOT produce sound level greater than 55 decibels (or level required by Code, if more stringent) in adjacent occupied areas. Sound level shall be as measured on A-weighting scale of sound level meter or sound survey meter.

B. Methods described in ASHRAE guide and data books may be used to determine sound level of equipment when total of background sound and equipment sound exceeds the required minimum.

C. Contractor shall ensure that equipment and materials provided as part of the Work do NOT produce excessive noise/vibration and do NOT transmit excessive noise/vibration to occupied spaces. If objectionable noise/vibration occurs, Contractor shall provide systems, devices, and equipment necessary to eliminate objectionable noise/vibration at no additional cost to Owner.

D. Refer to Section VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS in this Division for further requirements.

3.17 FINAL CLEANING

A. Clean each surface of each unit of work, to normal "clean" condition expected for a first-class building cleaning and maintenance program. Comply with manufacturer's instructions for cleaning operations. The following are examples, but not limitations, of cleaning required:

1. Remove labels which are not required as permanent labels.
2. Clean transparent materials, removing substances which are noticeable as vision-obscuring.
3. Clean exposed hard-surfaced finishes, until free of dust, stains, films and similar noticeable substances.
4. Wipe surfaces of mechanical and electrical equipment clean, remove excess lubrication and other substances.
5. Remove debris and surface dust from limited-access spaces such as plenums, shafts, and ceiling spaces.

6. Clean lighting fixtures and lamps; removing dust, smudge marks and protective wraps; so as to function with full efficiency.

3.18 DEMOLITION, RENOVATION, IMPACT TO EXISTING

A. Demolition:

1. In areas where demolition of systems of this Division are indicated, the following requirements apply:

   a. Disconnect and remove from the project site, and dispose of in a legal manner, all materials not otherwise identified to be handled otherwise.
   b. Investigate impact to areas outside the designated area for demolition and identify any impact that demolition may have on those areas.
   c. Building structure, partitions, floors, and walls to remain shall not be impacted by demolition work.

B. Selective Demolition

1. Major changes to existing building spaces and systems have been shown on Contract Drawings; minor changes have NOT been shown. Contractor shall anticipate that there will be numerous minor changes including:

   a. Removal and/or relocation of pipes, conduits, wiring, etc.
   b. Removal and/or relocation of wall and ceiling mounted devices due to architectural revisions or phasing.
   c. Temporary relocation of existing devices or distribution equipment to permit installation of new work.
   d. Temporary work and modifications to existing systems to maintain Owner’s use and operations in areas outside the boundaries of the work.
   e. Work related to phased demolition of existing systems.
   f. Work related to phased installation of new work.

2. Remove, store, clean and relocate equipment designated to be relocated and reused.

3. Material which is removed and is not designated for reuse shall, at the Owner's option, either:

   a. Be delivered to Owner's storage location
      OR
   b. Become Contractor's property and be removed from the site and disposed of properly

END OF SECTION 260500

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SECTION 260510 – PROJECT COORDINATION AND COORDINATION DRAWINGS

SECTION 260510 PROJECT COORDINATION AND COORDINATION DRAWINGS

PART 1 - GENERAL

1.1 REFERENCES

A. This section covers the specification of coordination of electrical work for the project. Refer to Section - COMMON WORK RESULTS FOR ELECTRICAL WORK, GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, applicable Sections of Division 1, and all other project instructions for other requirements.

B. GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS and DIVISION 1 paragraphs may be repeated in this Division for emphasis or for inclusion of more stringent/additional related requirements. Such repetition shall NOT be construed to reduce the requirements of those Divisions NOR to eliminate other requirements under those Divisions.

1.2 INTENT

A. The Contract Documents define a complete installation, comprised of many individual components, assemblies and systems. It is the intent of these documents that the work of all trade contractors, sub-contractors, and all sub-contracted entities performing the work be coordinated to result in finished project, meeting the performance requirements of these documents.

B. The use of the terms “contractor”, “trade contractor”, or “sub-contractor” in this Section is to be interpreted as referring to all trades, singularly and collectively.

C. Definition of roles and responsibilities as pertains to the scope of this section:

1. Contractor:

    a. Management, Schedule, and Execution of project coordination and coordination drawing process.
    b. Translation of Design Intent and Project requirements, presented within the Contract Documents, into coordinated layout and fabrication drawings.
    c. All reasonable efforts to resolve apparent conflicts in the work, identified in the coordination process, without impact to Design Intent and Project Requirements.

2. Architect/Engineer:

    a. Interpretation of Contract Documents
    b. Prioritization of Project Requirements where necessary to resolve multiple requirements determined as in conflict after Contractor’s coordination activities are exhausted.

c. Review and assistance with resolution of apparent conflicts identified by Contractor, provided that reasonable efforts by Contractor have been undertaken to first resolve apparent conflict.
d. Accept or Reject Contractor's proposed adjustments to the work.

1.3 RELATED SECTIONS

A. Refer to the following related sections:

1. DIVISION 1 – Section(s) related to Phasing, Construction Schedule, Procedures, and Coordination of the work.
2. DIVISION 21 – Section related to "Project Coordination and Coordination Drawings"
3. DIVISION 23 – Section related to "Project Coordination and Coordination Drawings"
4. DIVISION 26 - Section related to "Project Coordination and Coordination Drawings"

1.4 SEQUENCE OF WORK

A. Before commencement of project coordination and before procurement of materials, Contractor and all sub-Contractors, shall familiarize themselves with the work and requirements of all trades.

B. Phased Sequence of Work:

1. If provided, review phasing plans and requirements set forth in the Contract Documents and any Supplementary phasing information.
2. Contractor is responsible for generating a complete phasing plan for the project.
3. Identify work that requires careful scheduling in coordination with proposed phasing in order to meet project requirements for completion dates, and operation of systems.
4. Obtain clarifications from Owner and Architect/Engineer on requirements or conditions that directly affect scope work within specific phases of work.
5. Make adjustments to phasing plan and scope or work per phase after review and acceptance by Owner and Architect/Engineer.

C. Project Schedule(s):

1. Review schedules published in the Contract Documents and any supplementary information provided.
2. Coordinate sufficient time allocations in the Contractor's schedule for Shop Drawing submission and review, Procurement of materials, and the coordination process.
3. Identify elements that will establish the critical path to project completion at the designated date. Adjust schedule of work to accommodate the proper sequence of work as outlined herein.
4. Coordinate equipment arrival and rigging access to interface with overall project sequence. Coordinate and plan with manufacturer for any equipment "splits" required to set equipment in final location. If field breakdown is required, directions shall be

provided in writing from the manufacturer for procedures to be followed. Any field breakdown and reassembly is to be inspected by equipment manufacturer before final connections are made. Ensure an adequate pathway is available, such as corridors and openings, to transport equipment.

D. Investigation and Collection of Relevant Information:

1. Review all Contract Documents and referenced standards
2. Review all Owner requirements
3. Investigate field conditions as it relates to installation and coordination of work.
4. Identify areas where investigation requiring partial deconstruction of existing or newly constructed work is required to fully inform the Contractor on conditions that are critical to coordination of the work.
5. Perform investigations in coordination with the work of other trades and/or owner's use of existing areas.

E. Equipment Shop Drawings:

1. Shop drawings for major equipment and equipment with service connections, should be submitted and accepted prior to coordination drawing efforts in areas adjacent to equipment placement. Information on utility connections, weight and dimensions, access, working clearances, rigging methods, etc are to be represented on the Coordination Drawings for the specific equipment being installed.

F. Preparation of Coordination Drawings:

1. Coordination Drawings are to be prepared as a collaborative effort between all trade Contractors working on project.
2. The following information, as a minimum, is to be represented on the Coordination Drawing – Floor Plans:

    a. Accurately scaled to no smaller than 1/4" = 1'-0". Where areas are congested and smaller scale is insufficient to clearly detail aspects of the work, Contractor to provide documents at larger scale.
    b. Floor plan layout of walls, doors, windows, equipment pads, etc
    c. Building structure, dimensionally accurate with depth and elevation
    d. Ceiling systems, including reference to height and type of ceiling. Locate coordinated position of access doors where required to gain access to work. Soffits and other ceiling contours represented.
    e. Indicate by shadow or similar means, required access points for service to above ceiling components such as valves, clean-outs, strainers, fire dampers, VAV boxes, FCU's, pull boxes, control panels, etc.
    f. HVAC trade work:

        1) Ductwork
        2) Piping, including expansion loops

3) Elevation of ductwork and piping including allowances for insulation thickness indicated
4) Equipment – base/floor mounted
5) Equipment – suspended
6) Valves on distribution systems
7) Control Panels
8) Working clearances

g. Fire Protection Work:

1) Risers, Mains, and branch piping
2) Heads
3) Hose/valve cabinets
4) Valves on distribution systems
5) Detectors for special extinguishing systems
6) Service equipment
7) Fire Pump and trim
8) Panels / Control Panels
9) Working Clearances

h. Electrical Trade Work:

1) Electrical distribution equipment
2) Conduit runs for major feeders (panels and major equipment)
3) Branch circuit wiring collection boxes
4) Main Telecommunications conduits, racks, and/or open cabling space allowance
5) Pull boxes for major feeders and telecom conduits
6) Cable Tray
7) Lighting
8) Ceiling Mounted devices such as speakers, detectors, sensors, etc
9) Control Panels
10) Working Clearances both at floor level access and overhead access
11) Duct Smoke Detectors, indicated on duct layouts.

3. All trades contributing to the development of the Coordination Drawings are to sign off on the final completed documents, including the General Contractor (if applicable) and/or Construction Manager (if applicable).

G. Equipment Placement:

1. No equipment is to be placed before all connections and provisions have been verified and coordinated.
2. Working space and clearances for service are to be maintained and verified prior to placement of equipment support provisions such as pads, frames, supports, dunnage, curbs, or anchors.

H. Installation of Work:

1. Work is to be installed in conformance with coordination drawings that have been signed off and accepted.
2. Work installed prior to completion of the Coordination Process will be subject to removal at the Contractor's expense.

I. Changes made in the field:

1. The Coordination Drawings are to be periodically updated during the project to reflect changes to the work which are made by Change Order or adjustments for other cause.
2. Changes that result in coordination conflicts are to be resolved immediately before related work continues.

1.5 RENOVATIONS & EXISTING CONDITIONS (Where Applicable)

A. The Contract Documents do not necessarily show all existing conditions, all new work to existing work interfaces, nor the complete extent of patching, repair, and renovation.

B. Unless otherwise noted, work shall be planned and executed assuming that areas not scheduled at that time to be renovated are intended to be in use and occupied. Existing services must be maintained that serve occupied areas of the building(s) or site.

C. Thoroughly study, examine, and investigate existing field conditions including, but not limited to, conditions in areas of limited accessibility such as crawl spaces, plenums, attics, chases, and above ceilings.

D. Plan and execute investigative work, including selective demolition, of concealed spaces where new work is scheduled to be installed.

E. Coordinate investigative efforts so that the Owner's operations is not affected. Work after Owner's normal hours of operation may be required and is to be provided.

F. Interruption of building services to be scheduled to minimize impact to the Owner's operations. Interruptions may only be made after timely notification to Owner and any involved utilities. Advance notification requirements are to be investigated and incorporated into project schedule(s) to avoid impact to the orderly installation of the work. Overtime or after hours work may be required and is part of Contractor's responsibility.

1.6 AVAILABILITY OF ELECTRONIC FILES

A. Electronic files (CAD) of the project floor or site plans may be available from the project or Engineer. Refer to other Sections and Instructions of the Contract Documents to confirm if these will be made available. Unless otherwise stated, assume that electronic files will not be made available.

B. Electronic files (CAD) of the project's Mechanical and Electrical Contract Documents will not be made available unless otherwise stated.

1.7 SUBMITTALS

A. Submittal of Coordination Drawings to be made with sufficient time planned for review and revision. The potential for additional steps of coordination prior to the scheduled commencement of work should be anticipated.

B. Separately developed Coordination Drawings may be required for elements of the work. Refer to requirements outlined later in this Section.

C. Refer to other Sections and Divisions of these Specifications for other related Submittal requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. No specific materials are specified in this section. Refer to other sections of this Division and other Divisions of the Specifications for material specifications.

PART 3 - EXECUTION

3.1 TRADE SPECIFIC LAYOUT AND FABRICATION DRAWINGS

A. Trade or system specific layout drawings may be required in other Section of this and other Divisions. Content that is common between these layout drawings and requirements for the Coordination Drawings shall be coordinated and developed in parallel where practical.

3.2 SITE WORK AND UTILITIES

A. Coordination Drawing prepared reflecting:

1. Underground site utilities, size and invert
2. Site Structures for Utility Distribution, size, placement, invert
3. Include concrete encasement dimensions where applicable.

3.3 COORDINATION DRAWINGS – DEMOLITION

A. For renovation projects that require selective demolition, prepare a separate coordination drawing based on existing conditions, indicating:

1. Points of cut/cap for existing systems to remain
2. Major equipment removals and associated services

3.4 COORDINATION DRAWINGS – NEW WORK

A. Coordination Drawings prepared as indicated in this Section.

3.5 RISERS, SHAFTS, AND CHASES

A. Provide sections of all risers that extend beyond two floor levels of the building.

3.6 SECTIONS AND ELEVATIONS

A. Minimum of 1 longitudinal and 1 cross section through every Mechanical Room and Major Electric Service and Distribution Room

B. Cross sections to be provided in areas on congestion where services are stacked in elevation.

END OF SECTION 260510

TABLE OF CONTENTS
SECTION 260515 – BASIC MATERIALS & METHODS – ELECTRICAL

SECTION 260515 - BASIC MATERIALS & METHODS - ELECTRICAL

PART 1 - GENERAL

1.1 REFERENCES

A. This Section covers the specification of basic materials and methods for electrical work. Refer to Section – COMMON WORK RESULTS FOR ELECTRICAL WORK, GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, applicable sections of DIVISION 1, and all other project instructions for other requirements.

B. Refer to DIVISION 07 specifications – "PENETRATION FIRE STOPPING".

1.2 SCOPE

A. Provide labor, materials, services, equipment and transportation necessary for complete and operational electrical systems as indicated on Contract Drawings and specified herein.

B. Interface with work of Mechanical Trades (Divisions 21, 22, & 23):

1. Division 26 is responsible to supply disconnects, starters and motor controls NOT supplied integral to equipment provided under other divisions, unless otherwise noted.
2. Variable Frequency Drives (VFD) for control of motors which are integral to packaged equipment supplied under other Divisions will be supplied by that Division.
3. Variable Frequency Drives (VFD) will be provided by Division 23, unless otherwise noted.
4. Division 26 is responsible for all power wiring to and from Disconnect Switches, Motor Starters (including VFD's), and Motors, unless otherwise noted.
5. A source of power to feed mechanical control panels for Building Management (BMS, DDC, etc.) systems is to be made available by Division 26. Line voltage wiring from power source (breaker in panel) to control panels is to be provided by Mechanical Trade where wiring/homerun has not been indicated elsewhere on Contract Drawings. Coordinate with Division 23 Section, HVAC INSTRUMENTATION AND CONTROLS.

C. This section includes but is not limited to the following:

1. Conduit, cable and fittings
2. Pull boxes and junction boxes
3. Outlet boxes
4. Surface raceways
5. Backboards and equipment cabinets
6. Conduit hangers and supports
7. Wires and cables

8. Splices
9. Safety switches and fuses
10. Motor starters
11. Terminal strips
12. Labeling and identification

1.3 SUBMITTALS

A. Submit, for review, list of manufacturers and grade or type of material proposed, including wire, wiring devices, terminating systems, connectors, conduit, wireway and fittings. Submit samples if requested.

B. Submit for review shop drawings for all equipment and materials specified under this Section.

C. Prior to final inspection, submit test reports to Engineer for review.

D. Upon completion of job, furnish reproducible copies of wiring and interconnection diagrams required for clear and permanent record of interconnected equipment, such as alarms and annunciator panels.

1.4 COORDINATION DRAWINGS

A. Refer to Section, PROJECT COORDINATION AND COORDINATION DRAWINGS in this Division.

1.5 STANDARDS

A. All work shall conform to following standards:

1. NEMA Standards.
2. ANSI Standard CI: National Electrical Code (NFPA 70).
3. ANSI Standard C50: Rotating Electrical Machinery.
4. ANSI Standard C501-1: Construction and guide for selection, installation and use of electric motors.
5. ANSI Standard C52.1: Motors and generators (NEMA MG1).
6. ADA: Americans with Disabilities Act
7. Refer to Section COMMON WORK RESULTS for additional requirements

1.6 UNDERWRITERS LABORATORIES LABELS

A. Equipment, materials and components, for which there are listings in UL Product Directories, shall bear UL labels.

PART 2 - PRODUCTS

2.1 CONDUIT AND FITTINGS

A. The generic term “Conduit” when reference is made to method of installation and fittings, includes all types of conduit and EMT.

B. Rigid conduit (RMC) shall be UL listed, hot dipped galvanized steel with full cut hot dipped galvanized NPT threads. RMC shall be chromated on all surfaces for corrosion and abrasion protection. Connectors and couplings shall be galvanized steel threaded type listed for RMC use.

C. Intermediate metal conduit (IMC) shall be UL listed, hot galvanized steel with full cut hot galvanized NPT threads and factory-applied interior coating or lining for ease in pulling wires. Connectors and couplings shall be galvanized steel threaded type listed for IMC use.

D. Electric metallic tubing (EMT) shall be UL listed, hot galvanized steel with factory-applied interior coating or lining for ease in pulling wires. Connectors and couplings shall be galvanized steel, either compression type or heavy-duty set screw-type, listed for EMT use. Indent or crimp-type connectors are NOT allowed.

E. Non-metallic conduit (NMC) shall be rigid PVC, heavy-wall Schedule 40, UL rated, acceptable equivalent to Carlon "Type 40". Where non-metallic conduit is installed below paved areas, conduit shall be rigid PVC, heavy wall Schedule 80, UL rated and of same manufacturer as the Schedule 40 conduit.

F. Flexible metal conduit (FMC) shall be UL listed, single strip, spirally wound, corrosion-resistant, galvanized steel acceptable equivalent to Liquatite "Type BR". Use galvanized steel fittings and clamps listed for FMC use.

G. Liquid tight flexible metal conduit (LFMC) shall be UL listed, with a flexible core of single spiral wound strip of hot dipped galvanized steel and a liquid-tight jacket of flame-retardant, sun/oil/acid-resistant flexible PVC: Acceptable equivalent to Liquatite "Type LA". Connectors and couplings shall be zinc-plated malleable iron or steel, with engagement inspection window, locknut and sealing ring; liquid-, oil-, and rain-tight; suitable for wet locations; listed for LFMC use: acceptable equivalent to O-Z/Gedney "Type 4Q".

1. Grey/Tan Type LA liquid-tight flexible metal conduit (LFMC) shall be used for final connections to vibrating equipment.

H. Minimum Conduit and EMT size: 3/4”

I. Minimum Flexible Metal Conduit Size: 1/2”

J. Special Fittings

1. Where conduit penetrates air handling unit walls or plenums and in hazardous (classified) locations: provide sealing fittings acceptable equivalent to Crouse-Hinds "EYS Series".
2. Where conduit penetrates waterproof foundation, floor or roof: provide through-wall seals acceptable equivalent to O.Z./Gedney “Type CSMI” on each side of existing walls and O.Z./Gedney “Type FSK” on new walls.
3. Where conduit from underground distribution system enters building, provide cable terminators acceptable equivalent to O.Z./Gedney "Type CSB".
4. Where conduit is exposed at building expansion joint: provide expansion fittings acceptable equivalent to O.Z./Gedney "Type EX" or "Type EXE".

K. Where conduit is in concrete at building expansion or seismic joint and where conduit is exposed at seismic joint: provide expansion/deflection fittings acceptable equivalent to O.Z./Gedney "Type DX".

2.2 WIREWAYS AND SURFACE RACEWAYS

A. Wireways shall be steel, UL listed, with hinged or screwed covers by Lee Products, Keystone or acceptable equivalent.

1. Minimum Wireway Size: 4” x 4”

2.3 PENETRATION OF FIRE RATED CONSTRUCTION

A. Refer to Section 260545 for specific requirements for penetrations of fire rated construction.

2.4 PULL BOXES AND JUNCTION BOXES

A. Boxes shall be heavy duty, stamped steel with covers attached by screws. Provide locknuts for conduit size to which boxes are connected. In finished areas, boxes shall have neatly mitered frame and flush steel cover screwed to the frame.

B. Boxes shall be sized according to NEC.

C. Boxes shall be flush mounted where installed with concealed conduit, and surface mounted elsewhere.

2.5 BACKBOARDS & EQUIPMENT CABINETS

A. Backboards shall be 3/4” fire-rated plywood painted on all sides before installation, stamp/cable indicating “fire-rating” shall not be painted over.

B. Equipment cabinets shall be UL listed, sheet steel cabinet with hinged door with catch and lock; mounted on backboard. Cabinets shall be flush or surface-mounted, sized as required to suit equipment.

2.6 CONDUIT HANGERS AND SUPPORTS

A. Hangers, clips and accessories supporting conduit shall be UL listed.

B. Individual large conduits shall be supported by means of adjustable, malleable hangers of acceptable design placed on maximum 8'-0" centers. Individual small conduits may be held in place by one hole malleable clips.

2.7 WIRES AND CABLES

A. Secondary conductors shall be new copper with 600 V code gauge insulation, conforming to NEC requirements, and shall be Type THHN/THWN, rated 75° wet location/90° dry location except as follows:

1. Type XHHW rated 75° wet location/90° dry location shall be used for conductors #3 AWG and larger.
2. Ground wires shall be as specified under Section, ELECTRICAL GROUNDING in this Division, and in accordance with NEC.
3. Type MI cable shall be used where 2 hour ratings are required or where specifically shown in the documents.

B. Feeders and branch circuit conductors located above grade and within buildings shall be Type THHN/XHHW for use in dry or damp locations unless noted otherwise.

C. When wire sizes are not shown on Contract Drawings, sizes shall be in accordance with NEC but no smaller than following:

1. Light and power wiring: #12 AWG.
2. Control wiring: #14 AWG.
3. Wiring and cable for alarm and signal systems: as recommended by equipment manufacturer.

D. Miscellaneous cables and wires shall be new copper with 600 V code gauge insulation, conforming to NEC requirements as follows:

1. All Variable Frequency Drives (VFD) and harmonic filters shall have VFD cables as manufactured by Belden or equal for the following:

a. Sizes #12 AWG - #2 AWG, 600 VAC, UL1277, TC-ER, (3) stranded tinned copper conductors plus full size insulated ground, overall Beldfoil plus 85% tinned copper braid shield, full size drain wire, XLPE insulated conductors, black PVC jacket, 1000V UL flexible motor supply cable. Belden #29502 – 29507.
b. Sizes #1AWG - #4/0 AWG – Provide symmetrical design with (3) stranded tinned copper conductors plus (3) symmetrical bare copper grounds, (2) spiral copper tape

shields (100% coverage), XLPE insulation, black PVC jacket, 1000V UL flexible motor supply cable. Belden #29528- 29532.

c. Sizes 250kcmil, 350kcmil or 500kcmil, Belden #29533, 29534 or 29535.

E. Provide cable supports per NEC ARTICLE 300.19, acceptable equivalent to O.Z./Gedney "Type R" for large cables and Kellems "Grips" for bundles of smaller wires.

2.8 SPLICES

A. Splices for #10 or smaller wires shall be made with UL approved solderless connectors: spring type acceptable equivalent to Minnesota Mining and Manufacturing Company "Scotchlock"; or crimp-type acceptable equivalent to Thomas & Betts "Sta-Kon".

B. Splices, cable taps and terminals for #8 and larger shall be made with UL approved compression connectors: compression taps acceptable equivalent to Thomas & Betts "Colored Keyed" "C" taps applied with special tools according to manufacturer's recommendations; or bolted pressure connectors, bronze or copper construction, by Thomas & Betts, Burndy or acceptable equivalent.

2.9 APPLICATIONS – CONDUIT, CABLES, RACEWAYS

A. RMC: buried in floor slabs, in concrete walls, concealed in exterior masonry walls, wiring in fire pump rooms, hazardous locations, applications above 600 V.

B. IMC: where noted on drawings.

C. EMT: unless otherwise noted:

1. Feeders
2. Power wiring in mechanical rooms
3. Wiring for emergency and exit lighting
4. Wiring for emergency communication, security and alarm systems
5. Branch circuits
6. Control wiring, including work done under Division 23

D. LFMC: final connections to motors and equipment-mounted controls from minimum of 18” to maximum of 6 feet lengths.

E. NMC: sleeves through interior walls, below slab-on-grade, electrical ductbanks, and below grade unless otherwise noted.

F. EMT is NOT permitted as a substitute for rigid conduit; MC is NOT permitted as a substitute for flexible metal conduit.

2.10 SAFETY SWITCHES AND FUSES

A. Work of this Division shall include:

1. Furnishing and installing an appropriate fusible safety switch for each motor, unless otherwise noted.
2. Installation of safety switches furnished under DIVISION 23, MECHANICAL WORK.
3. Fuses for safety switches.
4. Power wiring to and from safety switches.

B. Disconnect Switches for Motor Starters

1. Provide disconnect switch ahead of each magnetic motor starter. The disconnect switch shall be located in sight of the controller location and not more than 50' apart.
2. Where more than one motor is connected to single branch feeder, provide fused disconnect switch for each motor, even if within sight of feeder branch breaker.
3. Motors requiring disconnecting means remote from the starter shall have a fused switch as close as possible to motor.

C. Safety switches shall have rejection clips for RK fuses and NEMA 1 enclosure, unless otherwise noted. Safety switches shall be NEMA Type HD (heavy-duty), manufacturer's specification grade switches by Square D, General Electric, or Westinghouse, acceptable equivalent to following:

1. Switches for use on 120/208 V system: rated for 240 V.
2. Switches for use on 480 V system: rated for 600 V.
3. Fused disconnect 2-pole and 3-pole: Square D "Type H".
4. Switches that are used in conjunction with variable frequency drives (VFDs) and elevators shall have auxiliary contacts that open before switch blades to interrupt control circuits. Auxiliary contacts shall be 120 VAC; 5 Ampere rated.
5. Switches for use with 6 lead motors: 600 VAC, NEMA 4X enclosure.

    a. Fused: Square “D” Type H

D. Fuses for safety switches shall be non-renewable dual element cartridge type, Class RK5, UL listed. Fuses shall be Bussmann #FRN for 208 V usage, and Bussmann #FRS for 460 V usage; or acceptable equivalent by Shawmut or Littelfuse. Install fuse so that size is readily visible. Special types and classes are indicated on Contract Drawings.

E. Provide one spare set of fuses for each type and size used with switches and other equipment.

2.11 EMERGENCY OFF STATION

A. Station shall be flush wall mounted, RED illuminated momentary contact switch to de-energize load, with clear, flip-up cover to prevent accidental activation.

B. Assembly shall include flip-up shield, and be labeled “EMERGENCY POWER OFF” STI #SS2024PO-EN or equal.

C. Assembly shall include text on cover reading “Lift to Activate” and labeled Emergency Fuel Pump Shutoffs, Emergency Stop, STI Inc. #SS2035 FS, ES –EN or equal.

2.12 TERMINAL STRIPS

A. Terminal strips shall be Buchanan or acceptable equivalent, with a numbering strip for identification of individual punchings.

PART 3 - EXECUTION

3.1 SUPERVISION

A. Furnish services of experienced electrical Superintendent who shall be constantly in charge of electrical work, together with skilled laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.

B. Particular emphasis is placed on timely installation of major apparatus and furnishing of other trades and Contractor with relevant information.

3.2 MOTOR AND CONTROL CIRCUIT WIRING

A. Provide wiring required for electrical equipment furnished under other Divisions of this Specification. Provide disconnects, starting switches and motor protection ahead of each piece of equipment, unless specified otherwise.

B. Check all protective and control equipment furnished or installed under this Division. Ensure that such equipment is properly sized for motor or other electrical equipment that it serves. Replace any material or equipment damaged due to improperly-sized protective control mechanisms.

C. Electrical controls and starters integral with or specialized for mechanical equipment may be specified with equipment in other DIVISIONS. Disconnects and other controls and starters are specified in this Division.

D. Output power wiring from variable frequency drive (VFD) to motor shall be run in metallic conduit; other wiring shall NOT be run in this conduit. VFD shall have separate equipment conductor back to ground bus of source panel or switchboard and shall NOT depend on metallic conduit for grounding. Power shall NOT be applied to VFD until VFD manufacturer has checked and approved VFD installation.

E. Control cable to VFD speed input shall be shielded and shall be installed without excess cable so that electrical noise shall be minimized.

F. Provide pair of control cable from auxiliary contacts of safety switch between VFD and motor to the VFD to interrupt control circuits. Control cable shall be minimum #14, 300 volt.

3.3 IDENTIFICATION

A. Distribution Equipment

1. All distribution equipment and associated electrical elements of mechanical equipment shall be identified according to the designations used in the Contract Documents or established in cooperation with the Owner/Architect as part of the as-built record drawings. Furnish directory indicating number, location and use of each item. Equipment requiring such numbering includes, but is not limited to the following:

    a. Switchboards/switchgear
    b. Switchboard/switchgear individual overcurrent protection devices
    c. Overcurrent protection device enclosures
    d. Transfer switches
    e. Disconnect switches
    f. Panelboards
    g. Transformers
    h. Equipment control panels and enclosures

2. Nameplates/Labeling: Center on device, coverplate or enclosure. Place on non-removable surface.

    a. Use abbreviations defined in the contract documents whenever possible. Use plan designations for labeling, unless indicated otherwise. Indicate loads served using designating from electrical schedules and designations from the trade furnishing the equipment served.
    b. Label the following with engraved lamicoid nameplates:
    c. Install nameplates inside covers in finished areas and outside covers in unfinished areas including mechanical, electrical and building maintenance areas.

3. Manufacturer's nameplate, name, trademark and address shall be attached permanently to equipment and material furnished under this division. Nameplate showing distributor or contractor will not be permitted.
4. Equipment designation nameplates shall be engraved lamicoid, sized as follows:

    a. Nameplates on panelboards, distribution panels and service switches: minimum of 1-1/2" by 2-1/2" size with name letters not less than 1/2" high and voltage, phase and number of wires not less than 1/4" high.
    b. Nameplates on starters and other equipment switches and devices: minimum of 3/4" by 2-1/2" size with letters not less than 3/8" high.

5. Each element of both essential and normal power systems shall be identified using the following background and letter colors:

Essential Systems:	Red background White lettering
Normal Systems:	Black background White lettering

6. Attach nameplates with rivets. Wherever covers of adjacent units are interchangeable, attach additional nameplates to wall or backboard adjacent to covers.

7. Essential power system equipment shall be identified indicating the associated essential power system branches as follows:

   Essential - Life Safety
   Essential - Critical
   Essential - Equipment

   a. See typical label details for additional information.

8. Panelboard circuit identification: engraved plastic nameplates for units without panel cover doors, or plastic covered circuit directory cards, type written, mounted on the inside of the panel cover doors.
9. Acceptable manufacturers for nameplates are Lamicoid, Seton or Brady.

B. Provide printed, colored, adhesive labels for all electrical equipment, such as but not limited to switchboards, panelboards, motor control centers, disconnect switches, etc. to warn qualified personnel of potential electric arc flash hazards. Label shall be a minimum of 4” x 5”, conforming to requirements of the 2015 Edition of NFPA 70E and requirements of OSHA.

C. Distribution Raceway Systems

1. Distribution raceway systems shall require system identification and shall include, but is not limited to the following:

   a. Conduit systems
   b. Pull boxes and junction boxes

2. Marker pen labeling shall be utilized on conduit and cable system junction boxes. Marker pen labeling methods shall be submitted for review prior to execution. Spray painting shall not be permitted. Systems requiring such identification include and shall be limited to the following:

   a. Junction boxes or portions of junction boxes containing 277/480 Volt or 120/208 Volt wiring.
   b. Communication and special system pull and junction boxes

c. Pull boxes and junction boxes installed for future use.

3. Marker pen labeling shall be on outside of junction and pull box coverplates and on the box itself in unfinished areas including mechanical, electrical and building maintenance areas and inside covers in finished areas.
4. Marking pen where used shall be permanent, waterproof and quick drying.
5. Conduits contain essential power system feeders and branch circuits shall be identified by attaching red vinyl adhesive backed decal with 1/2” high black letters on 1" high labels identifying essential power within 1'-0" of each termination or pull box and a minimum of every 25 feet of conduit run. Referenced labels shall be by Seton.
6. 2-hour rated cable shall be identified by same method as essential power system feeders.
7. Essential power systems feeders and branch circuit conduits shall be identified indicating the associated essential power system branch as follows:

   a. Critical
   b. Life Safety
   c. Equipment

8. Acceptable manufactures for underground warning tape, identification decals and vinyl adhesive backed labels are Seton or Brady.
9. Fire alarm system, junction boxes and recovery couplings shall be painted red. Provide vinyl label indicating fire alarm every 25 feet and at terminations.

D. Conductor and Cabling Systems:

1. Conductors size #6 and smaller shall have solid color insulation for identification.
2. Conductors size #4 and larger shall have color identification, six inches minimum length near termination and in splice boxes, junction boxes, panels and manholes. Identification shall be by solid color insulation, tape or paint.
3. Label tapes: Use for feeder, branch circuit control and special system conductors throughout. Indicate feeder and branch circuit numbers on both feeders and branch circuit conductors and terminal block termination numbers for control and special system conductors. Label conductors at origin and destination points and at all junction boxes, pull boxes and cable branch off points where installed in cable trough, wireway, monotray, cable ladder, etc.

E. Phase rotation shall be indicated by following color code:

Phase	**208Y/120V**	**480Y/277V**
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	White with color stripe or natural gray
Ground	Green	Green

F. 480V raceways including pull boxes and junction boxes shall have orange adhesive tape strips with pre-printed legend "480 Volts" affixed near terminations and at 25’ intervals. Preprinted tape shall be by Seton Nameplate, W.H.Brady or acceptable equivalent.

3.4 INSTALLATION OF CONDUIT, BOXES AND FITTINGS

A. Ends of conduits shall be reamed before assembly, and bushings and locknuts shall be provided where conduits connect to boxes.

B. Boxes shall be set plumb and square with building lines. Exposed conduit shall run parallel to building lines, unless noted otherwise, and shall NOT block ceiling inserts.

C. Maintain conduit and outlet boxes in position during construction of concrete floors, masonry walls, etc.

D. Wiring device boxes shall NOT be installed back-to-back in walls.

E. Conduit shall run to avoid low pockets which might collect water, and, during installation, open ends shall be capped.

F. Piping, ductwork, and conduit shall NOT be suspended and/or supported from one another and shall NOT physically contact one another under any circumstances. Provide independent support for electrical systems. Vibrating systems shall be kept free from non-vibrating systems.

G. Parallel groups of conduit shall be supported from below, either by horizontal angle irons or channel systems such as "Unistrut", with vertical hanger rods at appropriate intervals.

H. Supports for conduit on concrete walls shall be attached to wall with all metal expansion shields.

I. Final connections to motors, control devices mounted on equipment, vibrating equipment and vibration isolated equipment shall be made through liquid-tight flexible metal conduit.

J. Use standard radius bends on concealed conduit; on exposed work, use either standard bends or "L" type fittings acceptable equivalent to Crouse-Hinds.

K. Exposed wiring shall be kept as close as possible to underside of roof and floor slabs or bottom of beams, unless noted otherwise. Space above hung ceilings is extremely critical and coordination with mechanical trades is essential.

L. Conduit and wiring shall NOT be run in roof fill and shall NOT pierce roof deck, unless specifically noted to on Contract Drawings.

M. Field cut IMC and RMC conduits shall be field threaded. Field threads to be cold galvanized by brush or spray. Cold galvanize to be minimum 95% zinc and shall cure before attaching to threaded fitting. Set screw and compression fittings shall not be acceptable.

N. Conduit shall not be run directly above generator set exhaust system including piping, silencer, emission control equipment, heat recovery exchangers or any other equipment that contains hot exhaust gases.

O. Where PVC conduit, whether direct buried or in ductbank, terminates within a building or utility structure, the PVC conduit shall transition to rigid metal conduit at least 10 feet prior to entering building or utility structure. Additionally, sweeps up through slabs on grade shall be RMC.

P. Seal all conduits at the last structure prior to conduits entering a building and where conduits enter a building with Carlon “MAT” or “MAQ” series duct plug for conduits with wires and Carlon “MAE” series for spare conduits or equal. All spare conduits shall have nylon pull string and footage tape.

3.5 INSTALLATION OF CABLES

A. Parallel groups of cables shall be supported from below, either by horizontal angle irons or channel systems such as “Unistrut”, with vertical hanger rods at maximum of three-foot intervals.

B. Supports for cables on concrete walls shall be attached to wall with all metal expansion shields.

C. All insulated conductors run in plenum spaces shall be plenum rated and carry UL listing for flame spread and smoke propagation.

3.6 INSTALLATION OF BACKBOARDS AND EQUIPMENT CABINETS

A. Backboards shall be installed over sheetrock, screwed into wall studs or with screw anchors in masonry walls. Bottom of backboard shall be set at 6” AFF, extending to a maximum of 8’6” AFF.

B. Equipment shall be mounted to backboards at minimum of 4 points, with screws and washers.

C. Freestanding Unistrut framing for mounting of backboards or equipment cabinets shall be secured to floor and structure above.

3.7 MOTOR CONTROL

A. Mount grouped switches, starters and other equipment on backboards. See Paragraph BACKBOARDS & EQUIPMENT CABINETS in this section. Where wall space is not adjacent to equipment being served, or where additional wall space is required, provide free-standing assembly, constructed of metal uni-strut or similar, for mounting of equipment.

END OF SECTION 260515

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SECTION 260526 – ELECTRICAL GROUNDING

SECTION 260526 - ELECTRICAL GROUNDING

PART 1 - GENERAL

1.1 REFERENCES

A. This Section covers the specification of grounding for electrical equipment and systems. Refer to Section – COMMON WORK RESULTS FOR ELECTRICAL WORK, GENERAL CONDITIONS, SUPPLEMENTARY CONDITIONS, applicable Sections of DIVISION 1, and all other project instructions for other requirements.

1.2 SCOPE

A. Provide labor, materials, services, equipment and transportation necessary for complete and operational grounding systems as indicated on Contract Drawings and specified herein, including but not limited to following:

1. Service ground
2. Equipment grounds
3. Ground fault protection
4. Building and piping ground system

1.3 SHOP DRAWING SUBMITTALS

A. Submit for review shop drawings for the following:

1. Ground rods
2. Bus
3. Bushings and pressure lugs
4. Pipe clamps
5. Circuit breakers
6. Grounding conductors
7. Plug-in tester unit

PART 2 - PRODUCTS

2.1 SERVICE GROUND

A. Provide one green insulated copper grounding electrode conductor in 3/4” conduit from the service entrance switchboard ground bus to the grounding electrode system. Grounding electrode conductor shall be installed in one continuous length, without splice or joint, per NEC

Article 250. Grounding electrode conductor shall be #4/0 AWG unless otherwise noted on contract drawings or established by code.

B. Provide main bonding jumper per NEC Article 250. Jumper shall bond together equipment ground bus, switchgear enclosure and grounded service conductor (neutral) and shall be 500 kcmil unless otherwise indicated on contract drawings or established by code. Where main switchgear bus design meets the bonding requirements indicated, additional bonding conductors are not required.

2.2 EQUIPMENT GROUNDS

A. Provide green insulated copper equipment grounding conductor between the ground bus of the source distribution panel or switchboard and each load being served. Conductor shall be sized according to NEC Article 250, Table for “Minimum size of Equipment Grounding Conductors”.

B. Provide separate grounding conductor for each branch circuit.

2.3 GROUND FAULT PROTECTION

A. If excessive ground current flows in feeders to 480 V main switchboard, main breakers and/or circuit breakers with ground fault sensing shall trip to protect switchboard against arcing ground faults.

B. Provide ground fault circuit interrupter protection for receptacles as required and indicated.

2.4 MATERIALS

A. Ground rods shall be 3/4” x 10’-0” copper-clad steel, by Carolina or acceptable equivalent.

B. Below-grade and concealed connections shall be Thermweld, Cadweld or acceptable equivalent. Above-grade and exposed connections shall be Burndy or acceptable equivalent.

C. Wire shall be stranded bare copper or insulated copper, as indicated on Contract Drawings.

D. Bus shall be copper bar, as indicated on Contract Drawings.

E. Bushings and Pressure Lugs shall be by T&B, O.Z./Gedney or acceptable equivalent.

F. Pipe Clamps shall be by O.Z./Gedney or acceptable equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Refer to SECTION 260515, BASIC MATERIALS & METHODS - ELECTRICAL.

B. Grounding shall be installed and tested in accordance with NEC (NFPA 70) and to satisfaction of local electrical inspector and Architect.

C. If outlet is located within six feet of edge of sink or water source; GFCI/GFI receptacles shall be used.

3.2 EQUIPMENT GROUNDS

A. Equipment grounds shall be continuous from ground bus to electrical equipment and devices.

B. Provide equipment grounds for electrical equipment furnished or installed as part of this Contract.

C. Grounded service conductor (neutral) of 480Y/277 V distribution system shall be grounded at only one point: neutral connection to the ground bus. Under no circumstances shall system neutral be grounded at any other point. As part of final inspection procedures, demonstrate purity of system neutral.

D. Current return conductors (neutrals), which are grounded at the source, shall NOT be used for equipment grounding. Provide separate conductors for equipment grounding; refer to SECTION 260515, paragraph on IDENTIFICATION, for color requirements.

E. Grounding conductor shall be secured to equipment enclosure at power source (usually to a ground bus) and at apparatus being served by AC supply. Grounding conductors shall be insulated and shall be large enough to carry ground fault current safely.

F. Provide following for panelboards: neutral bus insulated from enclosure; and grounding bus bonded to enclosure. Grounding bus shall have means for termination of grounding conductors to panelboard cabinet.

G. Maintain electrical continuity of raceways by the following means:

1. Threaded fittings with joints made up wrench-tight where threaded rigid conduit is used.
2. Threadless fittings made up tight.
3. Metal bushing inside and locknut outside of metal boxes and cabinets when threaded conduit is used. If outside locknut is inaccessible for tightening after installation, provide additional locknut inside. If bushing is composed entirely of insulating material, use locknuts inside and outside.
4. Bonding jumper across joints of wireways, cable trays, expansion or deflection fittings, etc.
5. Devices listed for the purpose by UL.

H. NOTE: Addition of equipment grounding conductor to AC circuits run in metallic enclosures does NOT lessen the requirement for conductor enclosure continuity, since part of total ground

fault current will flow through the raceway and enclosure system. Therefore, the continuity of this system shall be maintained.

3.3 IDENTIFICATION

A. Provide identification as required in Section 260515.

3.4 TESTS

A. Acceptance testing for electrical grounding systems, specified herein, shall be performed by independent testing firm with minimum ten years experience in testing the specified items. Firm shall be member of International Electrical Testing Association (INETA).

B. Testing procedures shall be as described in INETA "Acceptance Testing Specifications" (ATS).

C. Testing firm shall immediately notify Contractor and Engineer, of any deficiencies requiring correction before electrical system is placed in service and shall confirm information in writing within five days.

D. Discrepancies found shall be corrected by firm which installed switchboard. However, testing firm shall make minor field adjustments that may be found necessary.

E. Test report shall include typewritten test results on firm's standard test forms.

F. Test and inspect the main grounding electrode system in accordance with Section 7.13 of the NETA Acceptance Testing Specification. Perform a resistance to ground test and ensure that resistance is no greater than 5 (five) ohms. Investigate and supplement grounding system where resistance exceeds recommended values and re-test as required.

G. Ground Fault Circuit Interruption shall be tested after installation by random connection of plug-in tester to various protected receptacles, as directed by Architect.

H. All ground fault systems including but not limited to the main service overcurrent protective device ground fault protection equipment shall be performance tested when first installed on site per manufacturer’s instructions and Section 7.14 of the NETA Acceptance Testing Specifications Inspection and Test Procedures for Ground-Fault Protection Systems. Tests shall include, but not be limited to, resistance measurements through all bolted connections, insulation resistance test on all control wiring and pick up tests using primary injection.

END OF SECTION 260526

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SECTION 312300 - EXCAVATION

SECTION 312300 – EXCAVATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, tools, materials, equipment and incidentals required to perform the work called for in this Section of the Specifications, including, but not necessarily limited to, the following:

1. The Contractor shall make all earth excavations and rock excavations, including removal of existing pavements, road base, curbs, walks, and abandoned pipes and structures encountered during removal of the existing 5,000 gallon fuel tank, and installation of the new 20,000 gallon fuel tank and all accessories, as required for the proper completion of the work included under this Contract, and shall dispose of all unsuitable excavated materials as specified herein.
2. The excavation shall include saw cutting of pavements and sidewalks, removal, handling, stockpiling and disposal of any and all materials encountered within the limits of the work, and shall include all pumping, bailing, draining, sheeting, shoring, cofferdamming and protection therefore.
3. The excavation of test pits as directed by the Engineer or Owner, or as required during construction to determine the location and depth of existing utilities, tanks, structures, etc.

B. Comply with ConnDOT Form 818 Article 2.05.01.

PART 2 - SUBMITTALS

2.1 Design Drawings

A. Prepare and submit the following design drawings. All design drawings shall be signed and sealed by an engineer registered in the State of Connecticut:

1. Excavation Plan - The excavation plan shall outline the methods and procedures that the Contractor will employ to successfully stabilize excavations, as required to construct the work. At a minimum, the excavation plan shall make provisions to support the existing on-site buildings and structures, all adjacent building foundations, and for the 20,000 gallon fuel tank installation.

2. Excavation Dewatering Plan - The excavation dewatering plan shall outline the methods and procedures that the Contractor will employ to successfully dewater excavation and dispose of the dewatering wastewater, including measures for erosion control and sediment removal.

2.2 MATERIALS:

A. "Earth Excavation" shall consist of all materials, with the exception of rock, removed as indicated or directed from within the excavation limit lines.

B. "Rock Excavation" – Rock Excavation shall be:

1. Rock in definite ledge formation.
2. Boulders, portions of boulders, cement-masonry structures or concrete structures, each discrete object a minimum of one cubic yard or more in volume.
3. Note: Pieces of concrete sidewalk, or concrete used for underground storage tank “dead-men” shall not be included in Rock Excavation, but included in Earth Excavation.

PART 3 - EXECUTION

3.1 Pavement and Concrete Sidewalk Saw Cutting

A. Saw cut existing pavement and existing concrete sidewalks as required prior to removing existing 5,000 gallon fuel tank, and prior to installation of new 20,000 gallon fuel tank, piping, and appurtenances.

3.2 Excavation

A. Structure excavation shall conform to Section 2.03 of ConnDOT Form 818.

B. Pavement, driveways, curbs and sidewalks shall be cut as required with a pneumatic tool or saw, removed, and disposed of by the Contractor.

C. If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted, suitable backfill material as described in Section 02-240, Compacted Granular Fill.

D. All suitable material removed in making the excavation shall be used for backfill where required. All surplus or unsuitable material shall be removed and disposed of by the Contractor. Suitable material is specified under Section 02-240, Compacted Granular Fill.

E. The Contractor shall note that there may be other existing utilities in close proximity to the work. These utilities have been indicated on the drawings, but the completeness or accuracy of the information given is not guaranteed. It is the Contractor's responsibility to make himself aware of these locations and to contact Call-Before-You-Dig prior to any excavation.

F. As the excavation approaches pipes, conduits or other underground structures, digging by machinery shall be discontinued and the excavation shall be done by means of hand tools. Such manual excavation, when incidental to normal excavation, shall be included in the work to be done under items involving normal excavation.

G. Where determination of the exact location of pipe or other underground structure is necessary for doing the work properly, the Contractor may be required to excavate test pits to determine such locations, at no extra cost to the Owner.

H. Until final acceptance of the work, the Contractor shall pump out, or otherwise remove and dispose of as fast as it may collect, any water or other liquids which may be found or may accumulate in the excavations. Perform this in full conformance with their approved Excavation Dewatering Plan.

I. There shall be upon the work at all times during the construction proper and approved machinery of sufficient capacity (including spare units kept ready for immediate use in case of breakdowns) to meet the maximum requirements for the removal of the water or other liquids and their disposal in such a manner as not to withdraw sand or cement from the concrete and so as not to interfere with the proper laying of pipe and/or masonry, or the prosecution of work under this or other contract, nor endanger existing structures.

J. All existing walks, pipes, conduits, poles, wires, fences, stairways, curbing, property line markers, walls, buildings and other structures which do not, in the opinion of the Engineer, require to be changed in location, shall be carefully supported and protected from injury by the Contractor without additional compensation, and in case of injury, they shall be restored by him without compensation therefor, to as good condition as that in which they were found.

K. Tree roots shall not be mutilated, nor shall they be cut, except by permission of the Engineer. When permitted to cut tree roots, the ends shall be cut off smooth, without splitting or shattering. The trunks of the trees shall be carefully protected from damage, and if unavoidable damage occurs, the injured portions shall be neatly trimmed and covered with an application of

grafting wax or other approved preparation. Power driven excavation machinery shall be handled with care to prevent damage to shade trees, particularly to overhanging branches, and branches shall not be cut off except by special permission of the Engineer.

L. The Contractor shall, at his own expense, dig up, handle, protect and properly reset hedges, small trees, shrubbery, signs, posts, guard rails, curbing other than bituminous and the like along the line of or adjacent to the work, and shall take all reasonable care in this work not to disturb any object that can be saved in its existing condition.

3.3 TEST PITS

A. The Contractor shall conduct test pits in locations directed by the Engineer or Owner, to provide more exact locations on existing utility or drainage infrastructure, or other items of interest to the Engineer. Included in these test pits will be saw-cutting of pavement (if in paved areas), traffic control where required, bracing of excavations as required, pumping of water as required, backfilling the test pit with materials removed during excavation, and placement of compacted gravel fill on the top 12” of the test pit.

END OF SECTION

SECTION 312300 – EXCAVATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, tools, materials, equipment and incidentals required to perform the work called for in this Section of the Specifications, including, but not necessarily limited to, the following:

1. The Contractor shall make all earth excavations and rock excavations, including removal of existing pavements, road base, curbs, walks, and abandoned pipes and structures encountered during removal of the existing 5,000 gallon fuel tank, and installation of the new 20,000 gallon fuel tank and all accessories, as required for the proper completion of the work included under this Contract, and shall dispose of all unsuitable excavated materials as specified herein.
2. The excavation shall include saw cutting of pavements and sidewalks, removal, handling, stockpiling and disposal of any and all materials encountered within the limits of the work, and shall include all pumping, bailing, draining, sheeting, shoring, cofferdamming and protection therefore.
3. The excavation of test pits as directed by the Engineer or Owner, or as required during construction to determine the location and depth of existing utilities, tanks, structures, etc.

B. Comply with ConnDOT Form 818 Article 2.05.01.

PART 2 - SUBMITTALS

2.1 Design Drawings

A. Prepare and submit the following design drawings. All design drawings shall be signed and sealed by an engineer registered in the State of Connecticut:

1. Excavation Plan - The excavation plan shall outline the methods and procedures that the Contractor will employ to successfully stabilize excavations, as required to construct the work. At a minimum, the excavation plan shall make provisions to support the existing on-site buildings and structures, all adjacent building foundations, and for the 20,000 gallon fuel tank installation.

2. Excavation Dewatering Plan - The excavation dewatering plan shall outline the methods and procedures that the Contractor will employ to successfully dewater excavation and dispose of the dewatering wastewater, including measures for erosion control and sediment removal.

2.2 MATERIALS:

A. "Earth Excavation" shall consist of all materials, with the exception of rock, removed as indicated or directed from within the excavation limit lines.

B. "Rock Excavation" – Rock Excavation shall be:

1. Rock in definite ledge formation.
2. Boulders, portions of boulders, cement-masonry structures or concrete structures, each discrete object a minimum of one cubic yard or more in volume.
3. Note: Pieces of concrete sidewalk, or concrete used for underground storage tank "dead-men" shall not be included in Rock Excavation, but included in Earth Excavation.

PART 3 - EXECUTION

3.1 Pavement and Concrete Sidewalk Saw Cutting

A. Saw cut existing pavement and existing concrete sidewalks as required prior to removing existing 5,000 gallon fuel tank, and prior to installation of new 20,000 gallon fuel tank, piping, and appurtenances.

3.2 Excavation

A. Structure excavation shall conform to Section 2.03 of ConnDOT Form 818.

B. Pavement, driveways, curbs and sidewalks shall be cut as required with a pneumatic tool or saw, removed, and disposed of by the Contractor.

C. If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted, suitable backfill material as described in Section 02-240, Compacted Granular Fill.

D. All suitable material removed in making the excavation shall be used for backfill where required. All surplus or unsuitable material shall be removed and disposed of by the Contractor. Suitable material is specified under Section 02-240, Compacted Granular Fill.

E. The Contractor shall note that there may be other existing utilities in close proximity to the work. These utilities have been indicated on the drawings, but the completeness or accuracy of the information given is not guaranteed. It is the Contractor's responsibility to make himself aware of these locations and to contact Call-Before-You-Dig prior to any excavation.

F. As the excavation approaches pipes, conduits or other underground structures, digging by machinery shall be discontinued and the excavation shall be done by means of hand tools. Such manual excavation, when incidental to normal excavation, shall be included in the work to be done under items involving normal excavation.

G. Where determination of the exact location of pipe or other underground structure is necessary for doing the work properly, the Contractor may be required to excavate test pits to determine such locations, at no extra cost to the Owner.

H. Until final acceptance of the work, the Contractor shall pump out, or otherwise remove and dispose of as fast as it may collect, any water or other liquids which may be found or may accumulate in the excavations. Perform this in full conformance with their approved Excavation Dewatering Plan.

I. There shall be upon the work at all times during the construction proper and approved machinery of sufficient capacity (including spare units kept ready for immediate use in case of breakdowns) to meet the maximum requirements for the removal of the water or other liquids and their disposal in such a manner as not to withdraw sand or cement from the concrete and so as not to interfere with the proper laying of pipe and/or masonry, or the prosecution of work under this or other contract, nor endanger existing structures.

J. All existing walks, pipes, conduits, poles, wires, fences, stairways, curbing, property line markers, walls, buildings and other structures which do not, in the opinion of the Engineer, require to be changed in location, shall be carefully supported and protected from injury by the Contractor without additional compensation, and in case of injury, they shall be restored by him without compensation therefor, to as good condition as that in which they were found.

K. Tree roots shall not be mutilated, nor shall they be cut, except by permission of the Engineer. When permitted to cut tree roots, the ends shall be cut off smooth, without splitting or shattering. The trunks of the trees shall be carefully protected from damage, and if unavoidable damage occurs, the injured portions shall be neatly trimmed and covered with an application of grafting wax or other approved preparation. Power driven excavation machinery shall be

handled with care to prevent damage to shade trees, particularly to overhanging branches, and branches shall not be cut off except by special permission of the Engineer.

L. The Contractor shall, at his own expense, dig up, handle, protect and properly reset hedges, small trees, shrubbery, signs, posts, guard rails, curbing other than bituminous and the like along the line of or adjacent to the work, and shall take all reasonable care in this work not to disturb any object that can be saved in its existing condition.

3.3 TEST PITS

A. The Contractor shall conduct test pits in locations directed by the Engineer or Owner, to provide more exact locations on existing utility or drainage infrastructure, or other items of interest to the Engineer. Included in these test pits will be saw-cutting of pavement (if in paved areas), traffic control where required, bracing of excavations as required, pumping of water as required, backfilling the test pit with materials removed during excavation, and placement of compacted gravel fill on the top 12" of the test pit.

END OF SECTION

SECTION 312310 – COMPACTED GRANULAR FILL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, tools, materials, equipment and incidentals required to perform the work called for in this Section of the Specifications, including, but not necessarily limited to, the following:

B. The placement and compaction of granular fill for use as:

1. As replacement for unsuitable soil removed during excavation
2. Structure backfill as designated on the construction drawings.
3. Trench backfill, once all suitable material that was excavated has been previously utilized.
4. As base materials below pavement and sidewalks.
5. In other areas as designated on the Contract drawings, in these Contract specifications or as directed by the Engineer.

PART 2 - MATERIALS

2.1 Compacted Granular Fill

A. Compacted Granular Fill shall conform to the requirements of Article M.02.02, ConnDOT Form 818. Admixtured and surface protective materials used to prevent the Gravel from freezing, must meet the approval of the Engineer.

B. Compacted Granular Fill used as pavement base, shall conform to M.02.03 of ConnDOT Form 818, Grading A, except that the top course shall conform to Grading "C" M.02.03.

C. Compacted Granular Fill used as trench backfill shall conform to M.02.01 of ConnDOT Form 818.

D. Compacted Granular Fill used under concrete pads for tanks shall conform to M.02.01 of ConnDOT Form 818, Grading A.

PART 3 - EXECUTION

3.1 Sampling

A. Submit one-gallon sample of Granular fill material, certified sieve sample of Granular fill material, proctor test results from a certified testing lab, along with location of proposed source to Engineer for approval.

B. Construction involving compacted Granular fill shall be in accordance with Section 2.14.03, ConnDOT Form 818.

C. Granular fill shall be compacted in no greater than 12" lifts.

D. The Contractor shall compact Granular fill until the dry density for each layer is not less than 95 percent of the dry density achieved by AASHTO T180, Method D. A minimum of one compaction test is required for each structure. Where compaction tests fail, the Contractor shall be required to recompact the soil or remove the soil and replace with more suitable material. Notify the Engineer a minimum of three days prior to requiring compaction testing. All compaction testing shall be conducted by and paid for by the Contractor.

END OF SECTION

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SECTION 312310 – COMPACTED GRANULAR FILL

SECTION 312310 – COMPACTED GRANULAR FILL

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all labor, tools, materials, equipment and incidentals required to perform the work called for in this Section of the Specifications, including, but not necessarily limited to, the following:

B. The placement and compaction of granular fill for use as:

1. As replacement for unsuitable soil removed during excavation
2. Structure backfill as designated on the construction drawings.
3. Trench backfill, once all suitable material that was excavated has been previously utilized.
4. As base materials below pavement and sidewalks.
5. In other areas as designated on the Contract drawings, in these Contract specifications or as directed by the Engineer.

PART 2 - MATERIALS

2.1 Compacted Granular Fill

A. Compacted Granular Fill shall conform to the requirements of Article M.02.02, ConnDOT Form 818. Admixtured and surface protective materials used to prevent the Gravel from freezing, must meet the approval of the Engineer.

B. Compacted Granular Fill used as pavement base, shall conform to M.02.03 of ConnDOT Form 818, Grading A, except that the top course shall conform to Grading "C" M.02.03.

C. Compacted Granular Fill used as trench backfill shall conform to M.02.01 of ConnDOT Form 818.

D. Compacted Granular Fill used under concrete pads for tanks shall conform to M.02.01 of ConnDOT Form 818, Grading A.

PART 3 - EXECUTION

3.1 Sampling

A. Submit one-gallon sample of Granular fill material, certified sieve sample of Granular fill material, proctor test results from a certified testing lab, along with location of proposed source to Engineer for approval.

B. Construction involving compacted Granular fill shall be in accordance with Section 2.14.03, ConnDOT Form 818.

C. Granular fill shall be compacted in no greater than 12" lifts.

D. The Contractor shall compact Granular fill until the dry density for each layer is not less than 95 percent of the dry density achieved by AASHTO T180, Method D. A minimum of one compaction test is required for each structure. Where compaction tests fail, the Contractor shall be required to recompact the soil or remove the soil and replace with more suitable material. Notify the Engineer a minimum of three days prior to requiring compaction testing. All compaction testing shall be conducted by and paid for by the Contractor.

END OF SECTION

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SECTION 322919 – GRASS SURFACE RESTORATION

SECTION 329219 – GRASS SURFACE RESTORATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. ConnDOT Form 818- State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, 2022.

1.2 SCOPE OF WORK

1. The scope of work in this Section includes the following items:

2. Furnish and place topsoil in areas designated on the Contract Drawings. Comply with ConnDOT Form 818, Article 9.44.01.

3. Establish turf in areas designated in the Contract Drawings. Comply with ConnDOT Form 818, Article 9.50.01. Erosion control matting is not required.

1.3 RELATED DOCUMENTS

1. ConnDOT Form 818.

1.4 SUBMITTALS

1. Material certification for topsoil.

2. Material certifications for grass seed, lime, fertilizer, and mulch.

1.5 PROJECT / SITE CONDITIONS

1. No special conditions apply.

1.6 SEQUENCING

1. Regrade areas disturbed by construction activities and establish turf immediately upon completion of subsurface construction.

PART 2 - PRODUCTS

2.1 GRASS SURFACE RESTORATION

1. Topsoil: Comply with ConnDOT Form 818, Article 9.44.02.

2. Turf Establishment: Comply with ConnDOT Form 818, Article 9.50.02.

PART 3 - EXECUTION

3.1 GRASS SURFACE RESTORATION:

1. Topsoil: Comply with ConnDOT Form 818, Article 9.44.03.

2. Turf Establishment: Comply with ConnDOT Form 818, Article 9.50.03.

END OF SECTION

SECTION 329219 – GRASS SURFACE RESTORATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. ConnDOT Form 818- State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, 2022.

1.2 SCOPE OF WORK

1. The scope of work in this Section includes the following items:

2. Furnish and place topsoil in areas designated on the Contract Drawings. Comply with ConnDOT Form 818, Article 9.44.01.

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1.3 RELATED DOCUMENTS

1. ConnDOT Form 818.

1.4 SUBMITTALS

1. Material certification for topsoil.

2. Material certifications for grass seed, lime, fertilizer, and mulch.

1.5 PROJECT / SITE CONDITIONS

1. No special conditions apply.

1.6 SEQUENCING

1. Regrade areas disturbed by construction activities and establish turf immediately upon completion of subsurface construction.

PART 2 - PRODUCTS

2.1 GRASS SURFACE RESTORATION

1. Topsoil: Comply with ConnDOT Form 818, Article 9.44.02.

2. Turf Establishment: Comply with ConnDOT Form 818, Article 9.50.02.

PART 3 - EXECUTION

3.1 GRASS SURFACE RESTORATION:

1. Topsoil: Comply with ConnDOT Form 818, Article 9.44.03.

2. Turf Establishment: Comply with ConnDOT Form 818, Article 9.50.03.

END OF SECTION