SPECIFICATIONS
for
PHASE 2
EMERGENCY GENERATOR AND DISTRIBUTION UPGRADES

GRIFFIN HOSPITAL
130 Division Street
Derby, Connecticut

GRIFFIN HEALTH

CONSTRUCTION DOCUMENTS
vZ# 2021144.01
May 10, 2024

Prepared by:

VANZELM
ENGINEERS
VAN ZELM HEYWOOD & SHADFORD, INC.
10 TALCOTT NOTCH FARMINGTON, CT 06032-1800
P: 860.284.5064 F: 860.284.5098
Connecticut | Massachusetts | North Carolina

TABLE OF CONTENTS
SPECIFICATIONS

DIVISION 26 - ELECTRICAL

260500	COMMON WORK RESULTS FOR ELECTRICAL
260510	PROJECT COORDINATION AND COORDINATION DRAWINGS
260515	BASIC MATERIALS & METHODS - ELECTRICAL
260526	ELECTRICAL GROUNDING
260545	PENETRATION FIRESTOPPING FOR ELECTRICAL
260548	VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
260560	ELECTRICAL TESTING
260574	OVERCURENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD ANALYSIS
262400	SERVICE AND DISTRIBUTION
263213	ENGINE GENERATORS
263600	TRANSFER SWITCHES

TABLE OF CONTENTS
DRAWING LIST

END OF TABLE OF CONTENTS

Attachment to Specification Book

PROPOSED SEQUENCE OF CONSTRUCTION

DEFINITIONS

1. **Contractor**: The prime contractor holding the contract with Griffin HealthCare for Phase 2 Emergency Generator
2. **Griffin HealthCare (GHC)**: The hospital, utilizing their in-house staff and outside contractors for support if needed.
3. "**G1**": Existing 1250kW generator to remain.
4. "**G2**": Existing 250kW generator to be removed.
5. **GEN-1**: New nomenclature for the existing 1250kW generator to remain.
6. **GEN-2**: Nomenclature for new 1250kW generator

CONTRACTOR PROPOSED METHOD OF PROCEDURE

The Contractor is responsible to develop a Method of Procedure (MOP) detailing the steps he/she or GHC will take for each part of their work, including providing a schedule which accounts for lead times for major equipment and anticipated quantity and duration of interruptions or shutdowns of specific electrical distribution within the Hospital. The MOP must be presented to, and approved by GHC and the Engineer prior to commencing with any work described here-in.

EARLY PHASE (by Project Contractor)

1. Coordinate work all trades hired by this Contractor so that an expedited installation can occur without any delays due to improper planning and coordination.
2. Coordinate with GHC for work and equipment being provided by GHC, including transfer switches, conduit and wiring supporting the transfer switches, as well as interfacing the work provided by this Contractor with that being provided by GHC.
3. Procure long lead items such as Generators and Switchgear, provide shop drawings as soon as possible.
4. Disconnect and remove existing fuel transfer system and piping to extent possible while leaving "G1" and "G2" operational, connected to the temporary fuel supply.
5. Coordinate steps necessary to reverse door swings and install new concrete pads in Generator Room

SPRINKLER SYSTEM WORK (by Project Contractor)

1. Revise sprinkler system piping and heads in Generator and Essential Distribution Rooms.

FUEL SYSTEM INSTALLATION (by Project Contractor)

1. Install new fuel maintenance system, fuel transfer system and daytank for existing GEN-1.
2. Install new FOS&R piping from capped ends of piping provided under Phase 1 into generator room to new fuel maintenance system and fuel transfer system.
3. Connect new fuel system pumping and fuel maintenance system to generator GEN-1.

4. After GEN-1 is determined to be fully operational, and being fueled from Phase 1 fuel tank, coordinate with GHC for disconnection and removal of existing temporary fuel tanks and associated piping into generator room, including connections to existing generator fuel systems
5. Installation of GEN-2 daytank, including connecting into the new fuel transfer system and maintenance system shall be included with the installation of GEN-2.

EXISTING 250KW GENERATOR "G2" REMOVAL (by Project Contractor)

1. Disconnect and remove feeder from Generator "G2" to manual transfers switch and from manual transfer switch to Panel "DEDP", including the removal of manual transfer switch.
2. Revise feed of Panel "DEDP" to be from 400A-3P C/B formerly feeding the manual transfer switch.
3. Remove existing intake air louver to facilitate removal of "G2" through areaway. This will be re-installed and left in operating condition until the installation of GEN-2 is scheduled.
4. Remove 250kW generator "G2" including daytank, radiator discharge plenum connection to aluminum plenum wall, day tank, connection to temporary fuel supply system and exhaust system up to roof. Install temporary patch to aluminum plenum wall.

ESSENTIAL DISTRIBUTION SWITCHBOARD – EQESBB (by Project Contractor and GHC)

1. Install new Switchboard (furnished by GHC) on new concrete housekeeping pad.
2. Contractor shall coordinate with GHC for connection of new essential feeder connections to automatic transfer switches at Chillers "CH-1", "CH-2" and "CH-3", Motor Control Centers "MCCB" and "MCCP". Connection to transfer switches and breakers in EQESBB provided by GHC. Contractor shall be present at any time GHC is working on equipment provided by Contractor. Conduit entries into EQESBB shall be done by Contractor, conduit extension from point terminated by GHC to enclosure of EQESBB will be by Contractor.
3. GHC shall provide essential feeder conductors from breakers in EQESBB to the automatic transfer switches serving Chillers "CH-1", "CH-2" and "CH-3", Motor Control Centers "MCCB" and "MCCP" to the emergency terminals of the ATSs. Connections of conductors to breakers by GHC in EQESBB shall be supervised by Contractor.

NEW STANDBY GENERATOR TRANSFER SWITCH – ATS-GEN (by Project Contractor and GHC)

1. Install new Transfer Switch (furnished by GHC) on concrete housekeeping pad.
2. Intercept existing feeder from GEN-1 to "MSEDP", connect/extend feed from GEN-1 as required to normal terminals of ATS-GEN. Connect/extend to "MSEDP" to load terminals of ATS-GEN.

NEW 1250KW GENERATOR – GEN-2 (by Project Contractor)

1. Install Generator (provided by Contractor) on new housekeeping pad.
2. Connect generator to new fuel system.
3. Connect radiator discharge plenum to aluminum plenum wall.
4. Install new exhaust piping up to roof.
5. Install new day tank, and FOS&R piping to fuel transfer and maintenance systems, connect radiator discharge to aluminum plenum wall.
6. Connect GEN-2 2000A output breaker #2 to emergency terminals of ATS-GEN.

7. Connect 2000A S.T. generator output breaker to EQESBB.
8. Install new intake air louver assembly in place of original intake air louver assembly in areaway wall.
9. Startup, test and leave generator GEN-2 ready for use to feed ATS-MCCB, ATS-MCCP, ATS-CH1, ATS-CH2 and ATS-CH3.
10. Startup and test new EQESBB and ATS-GEN in accordance with specifications.
11. Startup and test new ATSs ATS-MCCB, ATS-MCCP, ATS-CH1, ATS-CH2 and ATS-CH3 in accordance with specifications.

MISCELLANEOUS COORDINATION TASKS

1. The existing generator "G2" is anticipated to be rigged out of the Basement level through the intake air areaway, and new generator GEN-2 is anticipated to be rigged into place on the Basement level through the intake air areaway. To accomplish rigging in and out of the generator room, the existing intake air louvers will need to be removed and reinstalled at least twice (removal of "G2" and installation of new GEN-2). Care should be taken in the handling, disassembly, and reassembly of existing louvers until permanent new louvers are ready to be installed. Once generator GEN-2 is inside the Generator Room, permanent louvers may be installed.
2. The new Switchboard EQESBB and Transfer Switch ATS-GEN are anticipated to be rigged into the basement through the overhead door into the areaway at the east end of the Mechanical room, then through the mechanical space into the Generator Rm.
3. In order to provide the complete Essential Equipment Branch System, there will be several shutdowns and interruptions required. Provide GHC with adequate notice and coordinate with GHC as to timing and duration so that Hospital operation is minimally affected.

END of PROPOSED SEQUENCE OF CONSTRUCTION

Attachment to Specification Book

DELINEATION OF RESPONSIBILITY BETWEEN THE CONTRACTOR AND GRIFFIN HEALTHCARE

The following outline is provided to clearly define the intended scope of both the Contractor and Griffin HealthCare. There may be some overlaps for which coordination between the Contractor and Griffin HealthCare will need to work together to bring to closure. It shall be the responsibility of both parties to keep the other informed as to work completed or needed in order to proceed with their work in a timely and efficient manner. The schedule as set forth by the Contractor will be the timeline in which Griffin HealthCare must perform their tasks.

DEFINITIONS

1. **Contractor**: The prime contractor holding the contract with Griffin HealthCare for Phase 2 Emergency Generator installation.
2. **Griffin HealthCare (GHC)**: The Hospital, utilizing their in-house staff and outside contractors for support if needed.
3. "**G1**": Existing 1250kW generator to remain.
4. "**G2**": Existing 250kW generator to be removed.
5. **GEN-1**: New nomenclature for the existing 1250kW generator to remain.
6. **GEN-2**: Nomenclature for new 1250kW generator.

SCOPE PERFORMED BY THE GENERATOR PROJECT CONTRACTOR:

1. The Contractor shall provide the work to reverse the door swings to both the Generator Rm and Emergency Equipment Rm such that they swing into the adjacent mechanical/storage room, not Generator Rm and Emergency Equipment Rm.
2. The Contractor shall revise the sprinkler work as shown on the drawings.
3. The Contractor shall revise the feed of panel "DEDP" to be from switchboard "MSEDP" directly, in lieu of thru transfer switch prior to removal of generator "G2".
4. The Contractor shall provide the new generator GEN-2.
5. The Contractor shall replace existing 8" exhaust flue with new 16" exhaust flue as shown on the drawings.
6. The Contractor shall provide connection to the Phase I fuel supply piping, provide new fuel pumping and maintenance systems, day tanks and connect to both the existing GEN-1 and new generator GEN-2.
7. The Contractor shall provide connection of Phase I fuel tank monitoring wiring required between the monitoring panel and the new fuel maintenance and transfer pump systems.
8. The Contractor shall install new transfer switch ATS-GEN (furnished by Griffin Healthcare). between existing GEN-1 and new generator GEN-2.
9. The Contractor shall install new Equipment Branch Distribution Switchboard EQESBB (furnished by Griffin Healthcare).
10. The Contractor shall provide all necessary control/start circuit wiring between the existing GEN-1 and new generator GEN-2 through ATS-GEN.

11. The Contractor shall revise locations of existing generator support power, Panels "GPBA" and "GPBB" and install new Panel CRGH-1, CRGL-1 and 15kVA transformer in generator room.
12. The Contractor shall remove and replace intake air louver assembly.
13. The Contractor shall provide new generator GEN-2 radiator exhaust plenum and louver, connect to existing plenum wall.
14. The Contractor shall provide new supplemental exhaust/fan as shown on the drawings.
15. The Contractor shall be present and supervise terminations made by GHC in EQESBB to ensure GHC leaves the switchboard in proper condition for Contractor testing.

SCOPE PERFORMED BY THE GRIFFIN HEALTHCARE (GHC):

1. GHC shall purchase and deliver to project site (into Generator Room) ATS-GEN and EQESBB for installation by Project Contractor.
2. GHC will clear space in Switchboard "MSBB" Room to install new ATS-MCCP.
3. GHC will remove the reactor located adjacent to "MCCB" to install new ATS-MCCB.
4. GHC will remove piping on the east wall of the Mechanical Room immediately adjacent to Emergency Distribution Rm to install new ATS-CH1. Required per NEC dedicated space requirements.
5. GHC will ensure floor area is clear adjacent to existing disconnect switch for "CH-2" to install new ATS-CH2. Required per NEC dedicated space requirements.
6. GHC will revise ductwork in the area adjacent to Chiller #3, along Corridor wall to install new ATS-CH3. Required per NEC dedicated space requirements.
7. GHC will purchase and install (5) ATSs; ATS-MCCB, ATS-MCCP, ATS-CH1, ATS-CH2 and ATS-CH3.
8. GHC will provide conduit and wire as required and noted on the drawings to feed the new ATSs, both normal and essential, as well as tie the load lugs of the ATSs to the equipment served. Conduits shall be extended into the generator room for extension to EQESBB by the Contractor.
9. GHC will connect the new essential feeds that are provided by GHC for each of the transfer switches into the respective breaker in Equipment Distribution Switchboard EQESBB. Feeder requirements (qty of conduits) will be provided to the Contractor. The Contractor to be present when GHC is working on the switchboard.
10. GHC will extend generator start circuits from each of the new transfer switches to GEN-2 controller as required. The Contractor to be present when GHC is performing this work.
11. GHC will revise the feeding of Panel "HVLS2" from 100A-3P C/B in Panel "EEP" to new 100A-3P C/B in Panel "LSDPA" as shown on the drawings.

ADDITIONAL SCOPE COORDINATION BETWEEN CONTRACTOR AND GHC

1. After Phase I fuel tank is connected to existing generator, and unit is tested, and has been turned over to GHA, the Hospital will be responsible for the removal of the temporary fuel system in the areaway.

2. Extension/Connection/Routing of conduits provided by GHC to work/equipment provided by the Contractor will need to be coordinated between GHC and the Contractor.
3. Startup and testing of new generator GEN-2 shall be performed as part of the Contractor responsibility.
4. Startup and testing of new EQESBB shall be performed as part of the Contractor responsibility.
5. Startup and testing of new ATS-GEN shall be performed as part of the Contractor responsibility.
6. Testing of transfer switch operation from GEN-1 to GEN-2 and back shall be performed as part of the Contractor responsibility.
7. Startup and testing of new ATSs ATS-MCCB, ATS-MCCP, ATS-CH1, ATS-CH2 and ATS-CH3 shall be performed as part of the Contractor responsibility, with any corrective work at the transfer switches or wiring to ensure proper operation to be performed by GHC.

END of DELINEATION OF RESPONSIBILITY

u:\2021\2021144.01\specs\phase 2 contract specs\phase 2_delineation of responsibility.docx

TABLE OF CONTENTS
SECTION 010000 – GENERAL REQUIREMENTS

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

TABLE OF CONTENTS
SECTION 03100 - CONCRETE FORMWORK

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

TABLE OF CONTENTS
SECTION 03200- CONCRETE REINFORCEMENT

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

TABLE OF CONTENTS

SECTION 033000 – CAST-IN-PLACE CONCRETE

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

TABLE OF CONTENTS
SECTION 033053 – MISCELLANEOUS CAST-IN-PLACE CONCRETE

SECTION 033053 - MISCELLANEOUS 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 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

TABLE OF CONTENTS
SECTION 210500 – COMMON WORK RESULTS FOR FIRE PROTECTION

SECTION 210500 – COMMON WORK RESULTS FOR FIRE PROTECTION

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, 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. 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.

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, insurance carrier 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, but not less than 6.
4. 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.

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

1. 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. Certifications requested, including UL label or listing.
    f. 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.

2. 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.

3. 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.
4. 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 Architect/Engineer.

5. 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 Architect/Engineer
2. Contractor WILL be liable for impact to project schedule.

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

G. 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.

H. Options: Identify options requiring selection by Architect.

I. 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.

J. 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.

K. 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.

L. 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.

M. 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.

N. 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, 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 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. Actual routing of distribution systems
4. Actual equipment location
5. Location of concealed distribution work such a pipes, conduits, ducts, etc
6. Location of concealed work and access panels, where access for maintenance or service is required.
7. Changes made by Change Order
8. Details not on original Contract Drawing, but used for installation of the work.
9. Information on concealed elements which would be difficult to identify or measure later.
10. 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 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.

1.12 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 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 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) Warnings and cautions

      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. 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) Seismic inspection and certification
4) 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. Testing reports.
2. Other data, as required under pertinent Sections of these Specifications.

1.13 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 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 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.

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. Dimensional requirements for embedded anchors as necessary for support, vibration isolation, and seismic restraint.

2. Access and walkway requirements
3. 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, 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, 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 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, 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.

3.8 ACCESSIBILITY, ACCESS PANELS AND ACCESS DOORS

A. Locate equipment which must be serviced including motor starters, 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.

3.9 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.

3.10 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 Architect/Engineer's presence.

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

D. 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.

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

F. 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.

G. 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.

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

3.11 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. Safety concerns and protective equipment
    e. Cleaning
    f. 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.

3.12 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.

3.13 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, etc.
    b. Temporary relocation of existing piping or equipment to permit installation of new work.

c. Temporary work and modifications to existing systems to maintain Owner’s use and operations in areas outside the boundaries of the work.
d. Work related to phased demolition of existing systems
e. 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.

3.14 TEMPORARY FIRE PROTECTION

A. Provide temporary protection for the entire renovation areas while under construction. Protection shall be as required by the Authority Having Jurisdiction. If fire watch is not approved, provide a temporary piped sprinkler system installed to meet NFPA 13 standards.

B. At the end of each work day, the building sprinkler systems including alarm devices shall be made operational.

END OF SECTION 210500

TABLE OF CONTENTS
SECTION 210510 – PROJECT COORDINATION AND COORDINATION DRAWINGS

SECTION 210510 - 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.

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 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. 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. Fire Protection Work:

        1) Risers, mains, and branch piping

2) Sprinklers
3) Valves on distribution systems
4) Service equipment
5) 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).

F. 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.

G. 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.

H. 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 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

3.3 COORDINATION DRAWINGS – NEW WORK

A. Coordination Drawings prepared as indicated in this Section.

3.4 RISERS, SHAFTS, AND CHASES

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

3.5 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 210510

TABLE OF CONTENTS
SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

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. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Temporary fire protection for renovation work.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Base hydraulic calculations on a recent flow test (within 12 months of contract date). If a recent flow test is not available, arrange and/or conduct a fire hydrant indicating the following conditions:

a. Date:
b. Time:
c. Location of Residual Fire Hydrant R:
d. Location of Flow Fire Hydrant F:
e. Static Pressure at Residual Fire Hydrant R:
f. Measured Flow at Flow Fire Hydrant F:
g. Residual Pressure at Residual Fire Hydrant R:

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers or otherwise required by insurance carrier.
2. Sprinkler Occupancy Hazard Classifications as required per NFPA 13:

a. Building Service Areas: Ordinary Hazard, Group 1.
b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
c. General Storage Areas: Ordinary Hazard, Group 1.
d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.

3. Sprinkler Occupancy Hazard Classifications (HC) as required by FM Global. Classifications of areas not listed shall be coordinated with FM Global:

a. Hazard Category HC-1:
1) Atriums
2) Concealed Spaces
3) Gymnasiums
4) Hospitals and Nursing Homes
5) Kitchens
6) Offices
7) School Classrooms
8) Unused Attics

b. Hazard Category HC-2:
1) Auto Parking Garages
2) Boiler Rooms and Equipment Rooms
3) Mercantile Areas
4) Metalworking Shops
5) Retail Areas
6) Sports Arenas
7) Theaters and Auditoriums

c. Hazard Category HC-3:
1) Vehicle Repair Garages
2) Interior Loading Docks

4. Minimum Density for Automatic-Sprinkler Piping Design as required per NFPA 13:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
d. Special Occupancy Hazard: As determined by authorities having jurisdiction.

5. Minimum Density for Automatic-Sprinkler Piping Design based on the ceilings up to 30 feet per Factory Mutual Global (FMG) Loss Prevention Data Sheets.

a. HC-1: Wet 0.1 / 1,500
b. HC-2: Wet 0.2 / 2,500
c. HC-3: Wet 0.3 / 2,500

6. Maximum Protection Area per Sprinkler: Per UL & FM Global listings.
7. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft.
b. Storage Areas: 130 sq. ft.
c. Mechanical Equipment Rooms: 130 sq. ft.
d. Electrical Equipment Rooms: 130 sq. ft.
e. Other Areas: According to NFPA 13 or insurance carrier recommendations unless otherwise indicated.

8. Total Combined Hose-Stream Demand Requirement: According to NFPA 13 unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.

9. Hose demand and duration, sprinkler spacing and K factors shall be as required per FM Global data sheets.

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Grooved joint couplings and fittings shall be referred to on drawings and product submittals, and be identified by the manufacturer’s listed model or series designation.

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

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

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. HVAC hydronic piping and ductwork.
2. Items penetrating finished ceiling include the following:

a. Lighting fixtures.
b. Air outlets and inlets.

E. Qualification Data: For qualified Installer and professional engineer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13 and insurance carrier, that have been approved by authorities having jurisdiction, including hydraulic calculations. The fire protection contractor is responsible for submitting plans and hydraulic calculations to all authorities including FM Global, for approval before installing any piping or equipment.

1. Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or Model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

G. Welding certificates.

H. Fire-hydrant flow test report.

I. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

J. Field quality-control reports.

K. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

b. Flow test shall have been conducted within 12 months prior to working plan submittal. If not available in that time period, this contractor shall be responsible for conducting a new test.

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

C. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

1. All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

D. 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.

E. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.8 PROJECT CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Architect's, Construction Manager's and Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All new fire protection equipment, sprinklers, valves, piping and fittings and devices shall be UL listed and FM Global approved.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article in Part 3 Execution for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes. Section 2.2, Steel Pipe and Fittings indicates the generic ASTM, ASME, UL and AWWA requirements.

2.3 STEEL PIPE AND FITTINGS

A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

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

    a. Anvil International, Inc.
    b. Corcoran Piping System Co.
    c. National Fittings, Inc.
    d. Shurjoint Piping Products.
    e. Tyco Fire & Building Products LP.
    f. Victaulic Company.

2. Pressure Rating: 175 psig minimum.
3. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 536, ductile-iron casting; with dimensions matching steel pipe. In applicable sizes, fittings, shall be short pattern, with flow equal to standard pattern fittings. Basis of Design: Victaulic FireLock. Installation-Ready™ fittings for Schedule 10 grooved end steel piping is sizes NPS 1-1/4 through 2 ½ (DN 32 thru DN 65). Fittings shall consist of a ductile iron housing, prelubricated Grade "E" EPDM Type 'A' gasket, and ASTM A449 electroplated steel bolts and nuts. UL listed for working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).

4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include two ferrous housing sections, EPDM-rubber center-leg gasket, with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth, and ASTM A449 compliant bolts and nuts. Installation-Ready, for direct stab installation without field disassembly.

    a. Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support and hanging in accordance with NFPA-13, fully installed at visual pad-to-pad offset contact. (Couplings that require exact gapping at specific torque ratings are not permitted). Basis of Design: Victaulic Style 009N and 107N.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 SPRINKLERS

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

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.
4. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing and "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application. When insurance carrier requires larger Discharge Coefficient K Factors, such requirements shall be followed, i.e. in mechanical and electrical rooms and in laboratories, FM Global requires minimum 8.0 K Factor.

D. Sprinkler Finishes:

1. Bronze.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 291 and FM Global. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. All piping and fittings upstream of the main backflow preventer shall be NSF61 approved and comply with material requirements set forth in the Plumbing Code.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13 and FM Global.

D. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13 and FM Global.

E. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

F. Install hangers and supports for sprinkler system piping according to NFPA 13 and FM Global. Comply with requirements for hanger materials in NFPA 13 and FM Global.

G. Fill sprinkler system piping with water.

H. Piping shall NOT be installed directly above electrical switchgear and transformers. In sprinklered rooms, provide drain pan above electrical switchgear and transformers. Drain pan shall be 20 oz. copper or galvanized steel pan at least 4” wider than the electrical equipment. Pan shall be properly stiffened and braced with brass angles; supported to prevent sagging; with 2” turned-up edge, rolled over stiff brass wire, on each side. Seams shall be soldered and watertight. Provide 1” drip pipe, from pan, down to floor.

3.3 SPECIAL DESIGN AND INSTALLATION

A. Provide sprinklers and related piping in all rooms and areas, including all special conditions and as required by local and state codes, NFPA 13 and insurance carriers. Examples of such special conditions are as follows:

1. Obstructions to sprinkler spray patterns.

3.4 TEMPORARY FIRE PROTECTION

A. Provide fully piped sprinkler system in all renovation areas for temporary protection during construction. If approved by the Authority Having Jurisdiction, a 24 hour fire watch will be an acceptable substitute for piped system while areas are not protected.

3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

E. 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 tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

F. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

G. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts in accordance with the manufacturer’s latest published instructions. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Grooved couplings manufacturer’s factory trained field representative shall provide on-site training for contractor’s field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. Factory trained representative shall periodically visit the jobsite to ensure bet practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.

I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.6 SPRINKLER INSTALLATION

A. In any area where sprinklers are installed above other sprinklers – where the discharge of the higher sprinkler can wet the lower sprinkler – a 3” diameter water shield plate shall be provided with the lower sprinkler.

B. Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.

C. The sprinkler bulb protector shall be removable by hand, without tools or devices that may damage the bulb.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and FM Global.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. All main risers and equipment at fire service entrance shall have placards installed at the base, defining all hydraulic information as required by the NFPA and insurer.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13 and FM Global, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests if applicable. Operate as required.
7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports. Provide annular inspection test tags on all backflow prevention devices and certify test results for the initial installations.

3.9 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.10 PIPING SCHEDULE

A. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be the following:

1. Standard-weight Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 5, shall be the following:

1. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Upright Sprinklers: Rough bronze in unfinished spaces not exposed to view.

END OF SECTION 211313

TABLE OF CONTENTS
SECTION 230500 – COMMON WORK RESULTS FOR MECHANICAL

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

TABLE OF CONTENTS
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

TABLE OF CONTENTS
SECTION 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC 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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation; and general requirements for direct-drive equipment mounted on an EC external rotor motor with integrated control electronics and installed at equipment manufacturer’s factory or shipped separately by equipment manufacturer for field installation

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

C. Approvals of UL1004-7 (Standard for Electronically Protected Motors) and CSA C22.2 No. 77 (Motors with Inherent Overheating Protection) for EC motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T .

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: [Ratings, characteristics, and features coordinated with and approved by controller manufacturer.]

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Motors shall have a shaft grounding brush to prevent bearing failure from presence of voltage on the shaft.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 EC MOTORS

A. Description: Direct-drive equipment mounted on an EC external rotor motor with integrated control electronics.

B. Efficiency: EC motors to meet or exceed Super Premium Efficiency Class (IE4).

C. Service Factor: 1.10.

D. Bearings: Maintenance free ball bearings with long term lubrication and nominal service life of at least 40,000 operational hours.

E. Temperature Rise: Match insulation rating.

F. Insulation Rating:

1. For motors greater than 7HP – Class F or better
2. For motors 2.5-7HP – Class B or better
3. For motors 1-2.5HP – Class A or better

G. Electrical Requirements:

1. Motor to be suitable for use with all standard AC power supply systems.
2. Motor to include integrated electronics, low-noise commutation logic, and 100% speed control.
3. Motor electronics to take control input of 0-10 VDC/PWM for open loop speed control.
4. Each EC motor assembly shall have integrated harmonic reduction/power factor correction. Manufacturer to provide harmonic data.
5. Motor to have over temperature protection.
6. Electronics to have line under-voltage and phase failure detection capabilities.
7. Electronics to impose motor current limit.
8. Motor capable of soft starting.
9. Motor/electronics to have EMC interference immunity in accordance with EN 61000-6-2 (Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments).

H. Mechanical Requirements:

1. Complete motorized impeller assembly shall have been statically and dynamically balanced by the manufacturer per ISO 21940-11 or equivalent.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

TABLE OF CONTENTS
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

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

TABLE OF CONTENTS
SECTION 230518 – ESCUTCHEONS FOR HVAC PIPING

SECTION 230518 - ESCUTCHEONS 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. Escutcheons.
2. Floor plates.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated or rough-brass finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. Split-Casting Brass Type: With polished, chrome-plated or rough-brass finish and with concealed hinge and setscrew.

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type.
   d. Bare Piping at Wall Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping at Floor Penetrations in Finished Spaces: Split casing, floor plate cast brass with concealed hinge.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
   h. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.
   i. Bare Piping at Floor Penetrations in Equipment Rooms: One piece floor plate.

2. Escutcheons for Existing Piping:

   a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping at Floor Penetrations in Finished Spaces: Split-casting, floor plate cast brass with concealed hinge.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   f. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
   g. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
   h. Bare Piping at Floor Penetrations in Equipment Room: Split-casting floor plate.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

TABLE OF CONTENTS
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.

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

TABLE OF CONTENTS
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

TABLE OF CONTENTS
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

TABLE OF CONTENTS
SECTION 230713 – DUCT INSULATION

SECTION 230713 - DUCT INSULATION

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 insulating the following duct services:

1. Indoor, exhaust between isolation damper and penetration of building exterior

B. Related Sections:

1. Division 23 Section "HVAC Equipment Insulation."
2. Division 23 Section "HVAC Piping Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following:

a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; FlameChek.
    b. Johns Manville; Firetemp Wrap.
    c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
    d. Thermal Ceramics; FireMaster Duct Wrap.
    e. 3M; Fire Barrier Wrap Products.
    f. Unifrax Corporation; FyreWrap.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; CP-127.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster; 85-60/85-70.
    d. Mon-Eco Industries, Inc.; 22-25.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers; CP-82.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster; 85-50.
    d. Mon-Eco Industries, Inc.; 22-25.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Foster; 30-80/30-90.
    b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.
6. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
7. Service Temperature Range: 0 to 180 deg F.
8. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
9. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers; CP-50 AHV2.
   b. Foster; 30-36.
   c. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following:

a. Childers; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

1. Products: Subject to compliance with requirements, provide the following:

a. Childers; Chil-Glas No. 5.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster; Mast-A-Fab.
b. Vimasco Corporation; Elastafab 894.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Products: Subject to compliance with requirements, provide the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers; Metal Jacketing Systems.
b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Factory cut and rolled to size.
b. Finish and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

D. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Polyguard Products, Inc.; Alumaguard 60.
b. Childers.
c. Venture-Clad.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ABI, Ideal Tape Division; 491 AWF FSK.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    c. Compac Corporation; 110 and 111.
    d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.12 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. ITW Insulation Systems; Gerrard Strapping and Seals.
    b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; CWP-1.
        2) GEMCO; CD.
        3) Midwest Fasteners, Inc.; CD.
        4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; CHP-1.
        2) GEMCO; Cupped Head Weld Pin.
        3) Midwest Fasteners, Inc.; Cupped Head.
        4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
        2) GEMCO; Perforated Base.
        3) Midwest Fasteners, Inc.; Spindle.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    c. Spindle: Aluminum, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

    a. Products: Subject to compliance with requirements, provide one of the following:

        1) AGM Industries, Inc.; RC-150.
        2) GEMCO; R-150.

3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide the following:

a. C & F Wire.

2.13 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.
e. Impale insulation over pins and attach speed washers.
f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth or other jacket material that is not manufacturer approved for painting:

1. Painting of insulation jacket materials is prohibited.

B. Insulation with Manufacturer Approved Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, rectangular, exhaust-air duct insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

B. Exposed, exhaust-air plenum insulation shall be one of the following:

1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

END OF SECTION 230713

TABLE OF CONTENTS
SECTION 230940 – HVAC INSTRUMENTATION AND CONTROLS

SECTION 230940 – HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems and equipment.

B. Manufacturers:

1. Acceptable manufacturers of electronic and DDC controls are Allerton, Andover Controls, Automatic Logic, Barber-Colman, Carrier, Honeywell, Johnson Controls, Landis & Gyr Powers, Robertshaw and Trane.
2. Other manufacturers will NOT be considered unless specifically requested in writing and specifically approved by the Engineer.

1.3 SCOPE

A. Provide labor, materials, services, equipment and transportation necessary for complete and operational system of automatic temperature control and building management (i.e., DDC system), as indicated on Contract Drawings and specified herein, including, but NOT limited to, the following:

1. Controls for air systems including supply fans, heating coils, cooling coils, humidifiers, return fans, exhaust fans and dampers.
2. Variable volume air supply regulators and controls.
3. Controls for space heating systems including direct radiation, convectors, unit heaters.
4. Controls for heating hot water plant including water heater, circulating pumps and valves.
5. Controls for chilled water plant including chiller, chilled water and condenser water pumps, cooling tower fans and valves.
6. Controls for service hot water plant including water heater, circulating pumps and valves.
7. Heat recovery system controls.
8. Control piping.
9. Revisions and equipment necessary to interface with existing cooling plant equipment.
10. Removal and/or relocation of existing thermostats to accommodate work, as required and as shown.
11. Checking, servicing, adjusting and putting in proper operating condition: existing controls (such as duct pressure controls and dampers) in systems affected by the Work, so that new and existing components work together to produce the required results.

12. Furnishing of automatic control valves and dampers, pressure sensors and sensor wells to be installed under Division 23.
13. Building Management System including:

    a. Control of mechanical systems
    b. Monitoring
    c. Alarm
    d. Energy Management
    e. Energy use reporting
    f. Calculation of data for custom reports
    g. Color graphics of floor plans and mechanical systems
    h. Totalization logs
    i. Historical trend logs

14. Fire dampers, volume dampers and control dampers.
15. Smoke dampers.
16. Combination fire/smoke dampers.
17. Sleeves, escutcheons, seals, waterproofing and similar devices.
18. Thermometers.
19. Pressure gauges.
20. Utility rebate motors for all applications, unless noted otherwise.
21. High efficiency motors for all applications unless noted otherwise.
22. Standard motors for all applications unless noted otherwise.
23. Motor starters.
24. Painting as required under Division 23.
25. Hangers, anchors, guides, bases and other supports.
26. Access panels and access doors.
27. System identification, including valve tags.
28. Noise and vibration control.
29. Seismic restraints, including equipment bolts and welding.
30. Cleaning, lubrication, testing, balancing and adjusting.
31. Coordination drawings.
32. Record drawings.
33. Operating and Maintenance Manuals.
34. Instructions.

1.4 SHOP DRAWINGS AND OTHER SUBMITTALS

A. Make preliminary submittal of two sets of Pneumatic and Electric control drawings to Engineer for review before shop drawings are submitted through normal channels. The purpose of this preliminary submittal is to save time. Include the following information:

1. Temperature control ranges
2. Spring pressure ranges
3. Transducer ranges
4. Method of control
5. Control devices selected
6. Description of operation

B. Submit, for review, shop drawings for each item of material, equipment and system component furnished or installed as part of the work of this Section. Shop drawing requirements are specified under SECTION 230010, GENERAL REQUIREMENTS FOR MECHANICAL WORK and under DIVISION 1.

C. Shop drawings shall include control layout and data on sensitivity, pressure ranges, temperature ranges, means of adjustment, means of calibration, spring ranges and other data necessary for review of each device, its function and its intended application.

D. Devices on shop drawings shall be identified by numbers and letters. These identifiers shall also be used in description of operation, in control layouts and on data sheets for ease in cross-referencing.

E. Shop drawings shall include motor efficiency data for three-phase motors 1 HP and larger.

F. Submit circuit coordination information for review by Engineer and Contractor, indicating circuit requirements by electrical panel, i.e., panel identification and maximum load of each circuit required for control system. Submittal will be returned indicating Engineer's final determination of panels and circuits to be used.

1. Furnish copy of final circuit determinations to DIVISION 26 Contractor, for use in preparing panel directories. Information on circuits shall include control component and area served.

G. Furnish certificate from manufacturer of control system that expansion hardware and software shall be available for next 10 years.

H. Furnish ASME certified test certificates for receiver tank on air compressor.

I. Furnish instruction manual for review. Manual shall describe function and operation of all control and management system components and shall include trouble-shooting and operating procedures. Manual shall be easily understood, for use by Owner's personnel; shall show the total integrated control system; and shall include:

1. System description.
2. Control devices, including number, system, service, location and normal position of each.
3. Information on sequencing of related devices.
4. Calibration charts and instructions.

J. Submit software manual to Owner for review. Software manual shall describe programming and testing, including:

1. System overview and detailed description of each software feature.
2. Instructions for user operation, including verifying status and errors, changing passwords, and initiating or disabling control programs.
3. Description of programming language including commands, editing and writing control programs, algorithms, printouts and logs, mathematical calculations and passwords.

4. Copies of application program software and documentation necessary for Owner to interpret program and make any changes desired.
5. Instructions for user programming or reprogramming any portion of DDC system including control programs, algorithms, mathematical equations, variables, setpoints, time periods, messages and other information necessary to load, alter, test and execute DDC system.
6. Reference summary sheets, which compare control programs with pertinent information about hardware and field wiring information.
7. Point identification including terminal number, symbol, engineering units and control program reference number.
8. Field information including DDC system hardware and locations, device type and function, electrical parameters and record drawing reference numbers.

K. Submit data summary forms to Owner for review. Forms shall define following information, for inclusion into DDC system, for each point in DDC system.

1. Description of each piece of equipment and the functions to be controlled.
2. For each DDC system function, a listing of digital and/or analog hardware required to interface DDC system to equipment.
3. Listing of digital and analog alarms.
4. Listing of DDC system application programs associated with each piece of equipment. This listing shall include control algorithms and mathematical equations and shall be in easy-to-understand English format.

L. Upon completion of project, submit for review pneumatic control and electric control shop drawings corrected for "as-built" conditions. Shop drawings shall include final pressure settings, spring ranges, temperature ranges, throttling ranges and temperature control settings. Three copies of accepted "record" shop drawings shall be furnished to Architect.

1.5 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun, prepare Coordination Drawings showing size and location of mechanical pipes, ducts, equipment and appurtenances, relative to work of other trades.

B. Submit for review coordination drawings signed by following trades: sheet metal, plumbing, fire protection, electrical and other HVAC trades. Drawings shall be composite construction floor plans, developed and submitted electronically.

C. Preliminary coordination drawings shall be prepared as follows:

1. First: Sheet metal trade shall prepare coordination drawings, minimum ¼" = 1' scale, to be used as composite construction floor plans for coordination of trades. Plans shall show floor and ductwork layouts in detail, including ceiling heights, duct heights and sizes (including insulation), registers and diffusers, and light fixtures.
2. Second: As part of work of Division 21, fire protection trade shall draw fire protection piping, etc., on coordination drawings prepared by sheet metal trade.

3. Third: As part of Division 26, Electrical Work, electrical trade shall draw electrical distribution conduits, wires, panels and other electrical work, which must be coordinated with other trades; on coordination drawings which have been prepared by fire protection trade.
4. Fourth: As part of work on Division 23, plumbing trade shall draw waste piping, vent piping, water piping, risers and other plumbing work which must be coordinated with other trades; on coordination drawings which have been prepared by electrical trade.
5. Fifth: As part of work of Division 23, HVAC trades shall draw HVAC piping work which must be coordinated with other trades; on coordination drawings which have been prepared by plumbing trade.
6. Each trade shall use a different color code.

D. Coordination Meeting and Drawing Revisions:

1. Sixth: Contractor shall hold a coordination meeting with sheet metal, HVAC, fire protection, electrical and plumbing trades and shall resolve conflicts between trades. Coordination drawings are to assist in identifying trade conflicts.
2. Seventh: Sheet metal trade shall revise coordination drawings to reflect revisions to the various trade work (including sheet metal, HVAC, fire protection, electrical and plumbing trades), as determined by coordination meeting.
3. Eighth: Sheet metal, HVAC, fire protection, electrical and plumbing trades shall sign the revised coordination drawings as indication of their acceptance of the construction layout shown thereon.

E. Sheet metal trade shall submit the revised coordination drawings to Architect for review.

F. Coordination Drawings are for Contractor’s and Engineer’s use during construction and shall not be construed as replacing shop, “as-built” or record drawings required elsewhere in the Contract Documents.

1.6 CONTRACTOR QUALIFICATION REQUIREMENTS

A. Demonstrate capability to execute this Contract by submitting evidence of following:

1. Minimum of five years, actively engaged in the business of installing control and automation systems.
2. Manufacturer’s approved service facilities, located within the area covered by the installing office.

B. As requested, submit catalog data and letters or certificates from Owners of other buildings in which similar control systems have operated successfully as intended.

1.7 SERVICE

A. Provide necessary service, adjusting and checking of control and management systems, at no additional cost to the Owner, during 12-month period of guarantee.

1. This shall include service required to correct space temperature alarms and equipment control problems which are the result of control component malfunctions.
2. This shall NOT include service required to correct failure of mechanical equipment being controlled.
3. This shall include full system checkout and calibration during the 12th month of guarantee period.

B. Furnish service contract for Owner's consideration, which continues systems' service beyond the guarantee period. This is NOT part of the Construction Contract and is an extra cost to the Owner, at Owner's option.

1.8 INSTRUCTION TRAINING

A. Competent technicians shall provide { } hours of instruction to the Owner's personnel. Instructions shall include, but are NOT limited to, the following:

1. Familiarization with HVAC Control system, hardware and operation procedures.
2. Familiarization with Management System Hardware.
3. Use of management system.
4. Modifications of software packages.
5. Trouble-shooting and service procedures.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM – GENERAL REQUIREMENTS

A. All equipment shall be by one manufacturer, insofar as possible. Unless specified otherwise, equipment shall be fully modulating and state-of-the-art.

B. Contract Drawings do NOT show every control device and every location. It shall be understood that Specifications are the primary guide to control requirements and that, unless specifically excluded, every piece of heating and cooling equipment shown on Contract Drawings requires controlling device.

C. Control system shall be complete in all respects including:

1. Room, insert and immersion thermostats and sensors.
2. PE and EP switches.
3. Transmitters.
4. Relays.
5. Valves.
6. Dampers.
7. Air compressor assembly and refrigerated air dryer.
8. Control panels.
9. Electronic analog sensors: temperature, humidity, pressure, flow and/or others as required.

10. Digital controllers.
11. Central monitoring terminal (CMT).
12. Transmission power supply.
13. Operators' terminal and printer.
14. Air piping.
15. Pneumatic control piping.
16. Control wiring.
17. Auxiliary devices and accessories.
18. Interface with fire alarm system.
19. Modem/telephone interface and associated software.

D. Electronic monitoring system shall be UL listed or ETL approved.

E. Insofar as possible:

1. Sequencing shall be accomplished by selection and application of proper spring ranges to damper operators and valve operators; pilot positioners shall NOT be used in lieu of proper spring range selection.
2. Ranges and sensitivities of master controllers shall be selected to eliminate need for submaster controllers.

F. Provide power and control wiring, conduit, junction boxes, fittings and other electrical appurtenances that are required for complete and operational control and monitoring systems; conform to electrical standards, codes and requirements specified under DIVISION 26, ELECTRICAL WORK. This work shall include:

1. Wiring of control and monitoring devices and circuits carrying voltages up to and including 120 Volt, unless otherwise indicated.
2. Wiring of 120 VAC power feeds to temperature control panels, CPU, digital controllers, printer and other control system equipment.
3. Wiring required for interfacing with building fire alarm, security and emergency generator systems; including wiring between DDC panels and fire alarm system panels.
4. Wiring of control system including wiring from sensors to panels, wiring from panels to CPU, and wiring from CPU to operator's terminal.
5. Wiring to "Auto" side of hand-off-auto switches on units being controlled as part of work of this Division.
6. Wiring of devices controlled as part of the work of this Division, whether furnished under this Division or another Division. Examples of devices include: alarm device, relay, solenoid valve, actuator and electro-mechanical device at control cabinet.
7. Wiring of devices providing control inputs, whether furnished under this Division or another Division. Examples of devices include: smoke detector contact; fire alarm relay contact; pressure, temperature, limit level and motion switches; PE switch and analog sensor.
8. Wiring from temperature control panel to terminal strips.
9. Wiring between panel terminal strips and field-mounted devices.
10. Wiring from modems and alarm dialers to telephone jacks. Coordinate with Owner's telephone contractor.

G. For bidding purposes, unless otherwise indicated, closest appropriate electrical panel shall be assumed to have circuit(s) available for control system use. Coordinate selection of circuits for control system use, by special submittal; refer to paragraph 1.4.F where mechanical equipment is designed to operate on standby power during utility outages, derive all control power for end devices and panels/CPU from a standby power source.

H. Control and monitoring devices that are part of an engineered smoke control system shall be provided with emergency power.

I. Power wiring installed and terminated as part of the work of DIVISION 26, ELECTRICAL WORK, shall include:

1. Wiring of devices and circuits carrying voltages GREATER than 120 Volts, unless otherwise indicated.
2. Wiring of power feeds to disconnects, starters and electric motors.
3. Installation of, and wiring of line power to, fused disconnects for each air compressor.
4. Wiring from disconnects to equipment motor starters.
5. Wiring from equipment motor starters to equipment motors.

2.2 TRANSMISSION NETWORK

A. Automatic system shall have multi-drop digital transmission network that provides communication link between operator's terminal and all DDC panels.

B. System shall have error checking feature to ensure signal reliability and shall identify signal transmission network failures. System shall ensure signal quality and strength. System shall support multiple multi-drop trunks.

1. All multi-drop trunks shall be interfaced to the system via standard EIA interface.
2. When used with modems, multi-drop trunk shall interface to unconditioned voice-band 3002 telephone lines for remote building tie-in to automation system.

C. Transmission network shall be run in conduit or shall be shielded cable. Wiring shall NOT be run in same conduit with fire alarm, security, lighting, building power or other dedicated systems.

D. Transmission network speed shall be minimum 9600 baud rate.

2.3 CONTROL DAMPERS

A. Provide control dampers for each fan system, to allow effective modulation or close-off of air flow as required.

1. Dampers shall be low leakage design, with seals along both edges and ends of damper blades to provide tight closure. Air leakage of damper when in closed position shall NOT exceed 1% of system design volume at 1" w.g. differential pressure.

2. Dampers shall be sized for design velocities of 1500 fpm through free area of damper at maximum system air flows.
3. Two-position dampers shall have parallel blade linkage; modulating dampers shall have opposed blade linkage. Dampers shall be arranged for normally open or normally closed operation, as required. Linkage shall be serviceable without removal of entire damper.
4. Damper construction shall be suitable for damper operation at maximum fan pressure, without failure, binding or distortion.

B. Damper frames shall be either galvanized steel or aluminum, constructed to facilitate field assembly. Frames shall have openings or mounting clips which allow secure fastening of frame to surrounding ductwork, duct collar or fan housing.

C. Damper blades shall be either galvanized steel or aluminum, with maximum blade length of 48" in any section. Blades shall have suitable bearings for smooth operation and shall be interconnected to provide unison operation.

D. Provide stiffening or bracing for frame sections over 48" high.

E. Outdoor air dampers shall have separate minimum and maximum sections.

F. Provide insulated damper blades on outside air plenums, dog house louvers, etc., that do not have ductwork connected.

2.4 DAMPER ACTUATORS

A. Motor actuators shall have non-overloading motors, and shall be direct drive by Belimo or acceptable equivalent. Actuators shall have moisture- and corrosion-resistant construction suitable for the environment in which they are installed.

B. Actuator sizing and quantity shall be determined by control manufacturer:

1. As needed to meet system requirements.
2. As needed to provide sufficient power for smooth modulation over entire range.
3. As needed to be able to open or close damper without binding or damage, at pressure differential up to 4" w.g. for low pressure systems and up to 8" w.g. for medium and high pressure systems.

C. Provide actuator for each damper over four feet in length or height.

D. Each actuator shall be matched to the type of analog output available from the controller and shall have a matching control range.

E. Assembly shall include necessary mounting hardware and brackets.

F. Motors at outdoor air ducts (intake and exhaust) and motors interlocked with them shall have a power-fail safety device which return motors to their normal position.

G. Where required, provide end switches and/or feedback potentiometer to report actuator position.

2.5 AUTOMATIC CONTROL VALVES - GLOBE/PLUG TYPE

A. Provide automatic temperature control valves for services as indicated on Contract Drawings. Valves shall be normally open, normally closed or mixing type, as required. Unless otherwise noted, valves shall be as follows:

1. Valves 2" and smaller: Globe valve, 250# WOG, 150# WSP, bronze body, screwed ends.
2. Valves 2-1/2" and larger: ANSI Class 150, steel body, bronze trim, flanged ends.

B. Valve design shall allow disassembly of valve top, inspection and replacement of packing without system shutdown or valve body removal.

C. Provide following accessories:

1. Valve stem packing: low friction, tight sealing, of material and pressure rating suitable for service.
2. Valve stems of polished stainless steel or Monel, for valves 2-/12" and larger.
3. Valve actuators: suitable and sized for closing against system differential pressure; with proper spring ranges to facilitate sequencing application (pneumatic).

2.6 THERMOMETERS

A. Unless otherwise specified, local thermometers for central air system shall be provided under Division 23.

2.7 ELECTRONIC TRANSMITTERS AND SENSORS

A. Electronic Temperature Transmitters: shall be solid state; RTD, thermistor or IC type which transmit electric analog signal to DDC panel; shall have proper range and accessories to transmit temperature value to DDC panel with accuracy of +/-1°F; shall be field calibrated, wired between point of sensing and DDC panel.

B. Space Temperature Sensors: shall be thermistor RTD or IC type; with cover of brushed aluminum or as accepted by Architect; with locking vandal-resistant guards keyed alike.

C. Sensors for outdoor shall have suitable radiation shield and weatherproof enclosure. Outdoor air temperature sensor shall be RTD type with platinum element.

D. Sensors to measure discharge and return air duct temperatures shall use single point sensing. Sensor to measure mixed air temperatures shall be averaging type with minimum 20-foot capillary element or averaging probe type.

E. Pipe Immersion Temperature Sensors: shall have stainless steel immersion well and accessories. When installed on inlet and outlet of heat exchanger, sensors shall be selected from the same manufacturing run, certified to read within +/-0.1°F of each other.

F. Space or Duct Relative Humidity Sensors: shall be accurate to +/-3% when compared to accurate reference psychrometer, from 20% RH to 80% RH.

G. Low Pressure Transmitters for liquid differential pressure:

1. Transmitters shall have accuracy of +/-0.25%; shall be capable of withstanding system pressure applied to one port with no pressure on other port; shall be Setra #228, Viatran #323, Mamac #PR-284 or acceptable equivalent by Rosemont or Omega.
2. Provide three-valve manifold to simplify calibration. Provide mounting suitable to relieve stress on tubing and sensing transducer.
3. For differential pressures greater than 1.5 psi and low static head, Robinson-Halpern #150 is acceptable substitution.

H. Analog sensors shall be compatible with systems specified, carefully selected for the required span.

I. All sensor wiring - analog or digital, input or output - shall be capable of sharing single conduit runs without affecting signal performance. Sensor wiring shall be capable of sharing single conduit runs with switched 120 VAC or 240 VAC. If this is NOT possible, provide separate conduits for sensor wiring, to ensure signal integrity.

2.8 CONTROL PANELS

A. Control panels shall be fully enclosed, all metal construction. Panels shall have hinged door with full piano hinges or heavy duty concealed hinges, with locking latch or bolt-on cover plate and with work light and switch. All panel locks shall be common keyed. Panels shall be finished with two coats of enamel paint.

B. Indicating devices and manual adjustment devices required for routing operation of system shall be located on panel door or cover plate. Other devices shall be located on sub-panel within panel.

C. Panels shall have ample room for control device mounting and wiring.

D. Panels shall house control apparatus, relays, I-P transducers, EP and PE switches, gauges, and other items required to implement the control sequence.

E. Panel shall display: discharge air temperature, return air temperature, mixed air temperature, outdoor air temperature, and alarm lights.

2.9 SYSTEM SOFTWARE AND GRAPHICS

A. Provide software required for efficient operation of functions required. Software shall be modular in design with flexibility in expansion and revision of the system. Software shall include, as a minimum:

1. Complete database entry.

2. Configuration of application programs to provide the sequence of operation indicated.
3. Graphics of each system as shown on the I/O Summary Table.
4. Alarm limits and alarm messages for critical and non-critical alarms.
5. Configuration of reports and point summaries indicted.
6. Capability for graphic programming.

B. Software package shall display graphically, in different colors, the following system information:

1. General area maps, showing locations of controlled buildings in relation to local landmarks.
2. Floor plan maps, showing heating and cooling zones throughout the buildings. Colors shall provide visual display of temperature relative to zone's respective setpoints. Colors shall be updated dynamically as the zones' comfort conditions change. Setpoint adjustment and color band displays shall be provided as specified in paragraph 3.02.D.5 "Setpoints".
3. Mechanical system graphics, showing the type of mechanical system components serving each zone, by use of pictorial representation of components. Graphic shall provide current status of I/O points being controlled, as applicable to each piece of equipment, including analog readouts in appropriate engineering units, at appropriate locations on the graphic.

C. Each category of software shall consist of interactive software modules. Each module shall have an associated priority level and shall execute as determined by the program controller as defined in the real-time operating system.

D. Software package shall allow receipt of alarms and messages while in a functional mode other than energy management, i.e., incoming alarms shall be displayed while the operator is in word processing, spreadsheet or other operating mode. System must automatically: switch from non-energy management mode, respond to an alarm, and return to the exact position left in the previous functional mode.

E. Operator must be able to communicate and direct control functions through the use of two-button "mouse" operator interface to monitor and control functions and sequences within the system.

F. System shall operate on a "System" Format basis, regardless of the manner or hardware configuration in which the data is acquired. A "system" shall consist of a logical grouping of data points, related to a piece of mechanical equipment, an energy distribution system, or an architectural area. Output displays, logs of a point and logs of a group of points shall contain following information:

1. Graphic presentation of the system
2. User name of point
3. Point descriptor
4. Current value/status
5. Associated engineering units
6. Alarm description

G. System shall have capability to display setpoints and variables for each zone graphically. System shall allow setpoints to be changed in the graphics mode. System shall update the variable display continuously.

H. DDC/EMS shall be programmed to provide separate color graphic for:

1. Each piece of equipment being monitored or controlled
2. Each floor and zone being controlled
3. Each schedule
4. Each trend
5. Each report

I. Operator sign-on shall require as a signable password. System shall have up to 32 passwords, each of which may be one of six levels of system access.

J. Power Failure/Automatic Restart at the Control Module

1. Power failure shall cause the control module to go into an orderly shutdown with no loss of program memory.
2. Upon resumption of power, control module shall automatically restart and shall print out the time and date of power failure and of power restoration, at the respective central site system.
3. Restart program shall automatically restart affected field equipment. Operator shall be able to define an automatic power-up time delay for each piece of equipment under control.

K. Changes to database and program shall be done using standard procedures and shall be capable of being done while the system is on-line and operational. System shall allow changes to be made at the local site through a portable computer. System shall permit the operator to perform the following:

1. Add and delete points.
2. Modify point parameters.

L. Graphics software shall permit the easy construction of infinitely variable shapes and sizes through the use of the mouse pointing device. Graphics software shall be fully implemented and operational to accomplish the following:

1. Create a new graphic picture
2. Modify a portion of a graphic picture
3. Delete a graphic picture
4. Delete a portion of a graphic picture
5. Call up a graphic picture
6. Cancel the display of a graphic picture
7. Assign conditions which automatically initiate the display
8. Overlay alphanumerics and graphics
9. Save the graphic picture
10. Display the latest process data fully integrated with the graphic display

M. System shall be able to trend and to display, either numerically or graphically: each analog point, each digital point and each calculated point. System shall be able to display graphically simultaneously two trended points within a module function block showing the most recent sixty samples. Each field module shall be capable of storing the more recent 288 samples for every hardware point in the module, with sample intervals as small as one second. Operator shall be able to select and to display graphically the trends of up to four points simultaneously on a single trend graph.

N. System shall provide runtime information for digital output points and for digital input points, for modules, upon operator command. Maximum runtime limits shall be operator definable and shall be capable of automatically issuing a printed message when the runtime maximum is exceeded. Operator shall be able to reset the runtime accumulator. Runtime hours and start time date shall be retained in non-volatile module memory.

O. System shall allow receipt of alarms and messages while in a functional mode other than energy management, i.e., incoming alarms shall be displayed while the operator is using another mode such as word processing and shall allow the operator to automatically return to word processing after the alarm is received.

1. System shall distinguish between alarms and messages, with alarms having a higher priority.
2. System shall be capable of calling up to three different remote locations to deliver an alarm or message. Operator shall determine if alarms or messages are to be based on temperature limit, status, or off-normal reporting.
3. Text for operator alarm and messages shall be operator definable. System shall be capable of storing minimum 100 messages, each of different length.

P. Field modules shall be capable of calling the central processing unit during off-peak phone rate hours to automatically upload current and accumulated data. System shall be capable of reporting and archiving the following information:

1. Outdoor air temperature history and degree-day history.
2. Electric demand and usage history.
3. All trended points.
4. All alarms and messages.
5. Equipment runtime information.

Q. System shall be capable of reporting following information, for which archiving is not applicable:

1. All points summary.
2. Building operating schedules.
3. Printout of graphic screen.

R. Provide DOS-based text editor program which allows operator to create custom report and logging formats. Custom report generation shall be able to be initiated: manually, based on field occurrence, based on time and any combination. Operator shall be able to have the system:

1. Report the desired point data from the field.
2. Insert the data in custom report format.
3. Store the report on disk.
4. Print out the report on the system printer and/or a remote printer.

S. Provide following application software for optimizing energy consumption while maintaining occupant comfort:

1. Scheduled start/stop (OSS)
2. Optimum start/stop (OSS) and optimum enable/disable (OED)
3. Source temperature optimization (STO)
4. Demand limiting (DL)
5. Day/night setback (DNS)
6. Timed local override (TLO)
7. Direct digital unitary zone control

PART 3 - EXECUTION

3.1 COORDINATION

A. Coordinate with work of DIVISION 26, ELECTRICAL WORK, and work of other Sections of this Division for following:

1. Smoke alarms for air systems, indicated from dry contact relays at local temperature control panels. Relays shall be provided under DIVISION 26, ELECTRICAL WORK.
2. Power to control panels.

B. Provide self-tuning control loops or readjust hardware and software as necessary to compensate for equipment interactions and extremes of outdoor conditions while preserving efficiency and comfort.

3.2 INSTALLATION OF CONTROL WIRING

A. Control troughing and conduit shall be properly supported and anchored; shall be installed in harmony with building lines; and shall NOT interfere with maintenance, service or replacement of other equipment, conduit or piping.

B. Wiring and cables in mechanical equipment spaces or above hung ceilings shall be supported independently from pipes, conduits and ducts of other trades.

C. Wiring, cables and piping shall NOT be dropped over lighting fixtures nor allowed to lay directly on top of ceiling panels or panel support members.

D. Control cable to VFD speed input shall be shielded and shall be installed without excess cable so that electrical noise shall be minimized.

E. Wiring shall be concealed in occupied spaces and protected by conduit where exposed in mechanical rooms, floor-to-floor risers, drops to wall sensor boxes or where subject to damage.

3.3 INSTALLATION OF EQUIPMENT, SENSORS AND VALVES

A. Thermostats shall be mounted 6 feet above finished floors in corridors or stairs; elsewhere, they shall be mounted 66 inches above finished floors. Exact locations shall be coordinated with adjacent light switches and other wall-mounted devices. Space temperature sensor shall be mounted adjacent to thermostat.

B. Control valves shall be installed in true vertical position with operator on top.

3.4 ADJUSTMENT AND CALIBRATION

A. Calibrate, test and adjust controls and control system including pneumatic and electric controls, thermostats, valves, damper motors and relays until system is properly adjusted and ready for use. Management system's hardware and software shall be completely checked, test run and modified as required.

B. Be present for functional tests on systems. Before Engineer is asked to witness functional tests, ensure that:

1. Entire control and management system is complete.
2. Controls are calibrated.
3. Controlled devices and equipment have been physically inspected and checked to ensure that these terminal devices are under proper control and working smoothly over their entire range of operation.

C. Adjustment procedure shall include following steps:

1. Preliminary setup and calibration, as specified and as shown on shop drawings.
2. Physical checkout of all components for completeness and accuracy.
3. Review of system with Engineer.
4. Functional tests for Owner's benefit, instruction and acceptance.
5. Review of problems with Owner, rechecking adjustments and calibration as required. Review, rechecking and calibration shall occur NOT less than 30 days nor more than 60 days after systems have been in full operation.

D. Control and Management systems shall NOT be considered complete nor acceptable until:

1. All conditions of Sequence of Operation have been attained.
2. All temperatures are maintained within specified limits under all operating conditions.
3. All system damper leakage is controlled within specified limits.

E. Where pneumatic-actuated damper operators are required, provide current-to-pneumatic (I/P) transducers mounted within airflow control centers or DDC panels.

F. As part of work of this Section, provide calibration and adjustment of airflow control components and be responsible for setting control setpoints, operating sequences, and alarming systems contained within airflow control centers, to produce following overall system performance.

3.5 DEMOLITION: IMPACT ON EXISTING SYSTEMS

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

1. Relocation of control piping and control wiring.
2. Relocation of thermostats, due to architectural revisions.
3. Relocation of diffusers and registers.

B. Electrical connections to existing equipment which is to be removed or relocated, including motors, shall be disconnected under DIVISION 26, ELECTRICAL WORK.

C. Electrical system equipment shall be relocated or removed under DIVISION 26, ELECTRICAL WORK.

D. Remove, store and relocate mechanical equipment designated to be relocated and reused.

E. Existing piping, ductwork, controls and mechanical system equipment which are located in areas designated for demolitions and which are not designated to remain shall be removed under other DIVISIONS (by the General Contractor). Material which is removed and is not designated for reuse shall, at the Owner's option, either:

1. Be delivered to Owner's storage location, OR
2. Become Contractor's property and be removed from the site.

F. Existing piping, ductwork, controls or equipment which are to remain and which are disturbed or damaged during construction shall be replaced with appropriate new materials, equipment or components at no extra cost to the Owner.

END OF SECTION 230940

TABLE OF CONTENTS
SECTION 231113 – FACILITY FUEL OIL PIPING

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 fuel oil distribution pumps, 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. Day Tanks
6. Fuel oil distribution and management system
7. Fuel oil filtration system

1.3 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.

1.4 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. Fuel oil management system.
4. Connection to leak detection and monitoring system
5. Each type and size of day tanks including containment, leak detection, level controls and accessories. Indicate dimensions, weights, loads, components, and location and size of each field connection.

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.

1.5 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.

1.6 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.

1.7 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.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 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 day tanks and fuel oil specialties and related equipment that fail in materials or workmanship within specified warranty period.

1. Day 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.

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 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”.

2.3 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.

2.4 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.

2.5 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.

2.6 Fuel Oil Management System

A. Acceptable manufacturers subject to compliance with the specifications:

1. Preferred Utilities
2. Viking Pump
3. IMO Pump

B. Provide a factory assembled "Packaged" duplex fuel oil transfer pump set and fully integrated Fuel Oil Management System. System to be factory fabricated/tested and certified as a complete unit. Field assembled units are not acceptable. System must integrate with Leak Detection and Monitoring system.

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 day tank product level monitoring including alarms and leak detection and include LCD operator display, manual back-up stations, time and date stamped alarm and event summary.

D. Fuel Oil Pumps

1. Provide a duplex pump and straining set that is factory assembled with components piped and mounted on a common baseplate.
   a. Pipe shall be schedule 40 ASTM A-53 Grade “A” with ANSI B16.3 Class 150 malleable iron threaded fittings. Pump suction and discharge connections to the pump set piping shall be through stainless steel braided flexible hose.
   b. Baseplate shall include 3" high ¼” thick steel side rails continuously welded to contain potential leaks and shall extend beyond any fitting, valve, pump, strainer(s).
   c. Exterior shall be finished in oil resistant textured gray enamel.
   d. Provide a ½" containment basin plugged drain connection.
   e. Welded to the bottom of the basin are two 3” heavy steel channels with 9/16” bolt holes for mounting the pump skid on a field supplied housekeeping pad

2. Provide two (2) base-mounted positive displacement internal/spur gear rotary type pumps, with cast iron housing, and self-adjusting mechanical carbon ring seals. The pump shall be capable of developing 25” Hg. vacuum as factory tested, however, for normal operation, vacuum shall not exceed 15” Hg.
   a. Pumps shall be supplied with TEFC NEMA frame motors with non-overloading characteristics on all portions of the pump curve.
   b. Rotating parts shall have steel OSHA guards.
   c. Pump Isolation and Check Valves: Each pump shall be provided with a suction and discharge isolation full port ball valve rated at 250 CWP and a class 125 CWP discharge check valve.
   d. Pumps and motors shall be mounted with bolts threaded into the steel channel for ease of maintenance. Mounting bolts shall not penetrate the secondary containment basin
   e. Pumps with internal relief valves shall not be accepted

3. Fuel Oil Strainers:
   a. One (1) Duplex strainer factory installed and piped on the suction side of each pump.
   b. Strainer to be sized for less than ½ psi of mercury drop through a clean strainer basket with the maximum flow in the suction line.
   c. Strainer shall be one-piece cast-iron body and shall be suitable for 200 psi.
   d. Strainer baskets shall be 40 mesh stainless steel.
   e. Strainer shall come complete with quick opening covers with airtight seals.
   f. Strainer shall be by Preferred Utilities Model 72 or approved equal.
   g. Strainer shall be equipped with a factory mounted and wired differential pressure switch to indicate that the basket needs to be cleaned. Indicating scale plate shall be

three-position color-coded for easy indication of strainer basket flow status. Switch shall provide indication on the main pump set control cabinet to alert operators.

4. Relief Valves:
   a. Provide two (2) relief valves sized to relieve the full outlet flow of the pump without causing the pump motor to overload or any component's pressure rating to be exceeded if the discharge is inadvertently valved off.
   b. Relief valves shall be externally mounted from the pumps and piped to the storage tank in accordance with International Mechanical Code and NFPA 30. Relief valves shall be Preferred Model "R" or approved equal.

5. Pressure and Compound Pressure Gauges
   a. Provide a 2.5" dial face compound gauge on the suction side of the strainer. The gauge shall read 30" vacuum - 15psig. The gauge shall be equipped with an isolation ball valve.
   b. Provide a 2.5" dial face pressure gauge on the discharge side of each pump. The gauge shall read 0 psig – 100psig. Each gauge shall be equipped with an isolation ball valve.
   c. Gauges shall have stainless steel cases and have a brass movement with bronze Bourdon tube.

6. Pump Automatic Sequencing Flow Switch
   a. Provide a flow sensing switch to be mounted on the pump set discharge piping to start the lag pump when the lead pump fails to maintain flow.
   b. Flow switch shall be vane operated to actuate a single double-throw snap switch. Switch shall be factory wired to the control cabinet for alarm and backup pump operation. Switch shall be rated for 1000 psig.
   c. Provide an isolation valve downstream of the flow switch for maintenance of the flow switch without draining the fuel system.
   d. Manufacturer: Preferred Utilities Mfg. Corp. Model 11160 or equal.

7. Containment Basin Leak Detection Switch:
   a. Provide a factory mounted and wired magnetic float operated containment basin leak detection switch to energize an audible and visual alarm should a leak be detected.
   b. The leak sensor shall be a plasma welded stainless steel construction.
   c. The leak sensor shall be internally mounted within the pump basin.
   d. Electrical connections shall be contained in a factory installed weatherproof junction box.
   e. Float shall be suitable for up to 250°F.
   f. Manufacturer: Preferred Utilities Mfg. Corp. Model PS-LDS or equal.

E. 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 transfer pumpset control panels shall be integrally mounted and wired to the pump skid with provisions to accept wiring from Leak Detection and Level Monitoring 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. Day tank control panels shall be factory mounted and pre-wired to the day tank level control probe and rupture basin leak detection switch.
4. The field mounted fuel oil specialties shall be field wired to the day tank control panel.
5. 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

6. 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.

F. Sequences of Operation
1. Day Tank
a. Generator Day Tank Level Control, Lead-Lag Operation, Fuel Pump Alternation
1) When the respective Day Tank oil level falls below 50%, the flow control manifold valves shall be opened and lead fuel pump shall be energized The lead pump shall continue to operate until the day tank level is greater than 80% at which point the pump shall stop and the flow control manifold valves shall close.
2) Upon the next call for fuel, the lead pump shall be automatically alternated.
3) The control system shall automatically energize the back-up pump upon detecting a low-level condition, (40% full condition). Both pumps shall then continue to operate until the level of oil reaches the high-level point (90%).
4) Upon detection of loss of flow or lead pump thermal overload the control system shall automatically energize the backup pump and de-energize the lead pump.

b. Overfill Prevention
   1) 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.
   2) Upon activation of the high switch the fuel oil management system shall sound an alarm and shutdown all active supply fuel oil transfer pumps and close flow manifold control valves.
   3) Upon activation of the high-high level switch the fuel oil management system shall sound an alarm, shutdown all active supply fuel oil transfer pumps, and close flow manifold control valves. and activate the day tank fuel oil return pump which shall run until the oil level is below the high-level point (90%).

c. Leak Detection
   1) The Fuel Oil Management system will monitor the status of the day tank leak detector
   2) Upon activation of the leak detector the fuel oil management system shall sound an alarm, shutdown all active fuel oil transfer pumps, and close flow manifold control valves.

d. All alarms to be annunciated locally and remotely to BMS

2. Automatic Pump Prime/Suction Line Integrity Test.
   a. The Fuel transfer system suction piping, pump prime and pump operation are automatically verified each week (adjustable).
   b. A three-position motorized ball valve is required for day tank bypass
      1) The day tank bypass valve is energized and all valve positions (FOS, FOR and bypass) are verified.
      2) Once valve positions are verified, the lead pump is energized. Once the lead pump has proven flow, the lag pump is energized, and flow is proven.
   c. Each flow test is recorded in the controller memory with a time-date stamp.
   d. If either lead or lag pump fails the flow test, the control system generates an audible and visual alarm and logs the “failed pump” condition.
   e. The day tank return pump(s) shall be similarly tested whereby each return pump shall be activated and return oil back to the main tank continuing until the day tank low level switch is activated. The return pump shall stop and the lead supply pump will restart.
   f. The Supply pump will refill the day tank up to the 90% level, activating that switch again. The supply pump will shut off and the return pump restart until the day tank level has dropped to the supply pump-off level. The supply pump will finally restart and fill the tank back to the pump-off (80%) level and then stop.
   g. This test sequence will demonstrate that not only the supply and return pumps, but also all level switches in the day tank are functioning properly. If during this sequence, any pump or level switch shall prove faulty, the control system shall generate an audible and visual alarm and log such event as a "failure" condition.

3. Main Fuel Oil Storage Tank(s) Gauging, Overfill Prevention and Leak Detection

a. The Fuel Oil Management system shall monitor the main storage tank level sensor, backup high level switch, and discriminating leak sensor monitoring via Leak Detection and Level Monitoring control panel provided as part of Phase 1.
b. Upon storage tank level greater than 90% full, pump running circuit of the return pump(s) shall be interlocked with the High Level Switch at the Leak Detection and Level Monitoring control panel, 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.
c. The controller must be field expandable using plug-in input modules to monitor up to 8 storage tanks and 24 discriminating leak sensors.
d. Provide all equipment capabilities specified in this paragraph even if level and leak sensors are not included in this project.

4. 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.

G. 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.

2.7 DAY TANKS (Remote from Generator)

A. Provide a UL 142 listed 200-gallon horizontal steel rectangular single wall fuel oil day tank with 200% rupture basins.

B. Acceptable manufacturers subject to compliance with the specifications:

1. Tanks:

    a. Preferred Utilities
    b. Modern Welding
    c. Pryco

2. Return Pumps:

    a. Preferred Utilities
    b. IMO
    c. Viking

C. Dimensions, capacities and connections as shown on drawings and schedules and supplied as detailed below

1. Tank shall be single wall steel
2. Tank to be factory tested to withstand 5 PSI, unless higher rating is noted on plans or schedules.
3. Tank connections shall include:
    a. fuel inlet with drop tube
    b. fuel oil overflow/return
    c. Manual fill
    d. tank level control probe
    e. engine supply with drop tube
    f. engine return with drop tube
    g. Vent connections as required by code
    h. Rupture basin drain
    i. Removable and gasketed 6" square inspection plate
4. Tank to be provided with the following accessories:
    a. Mechanical fuel level gauge
    b. vent cap
    c. 2" gasketed oil-tight manual fill cap.
5. Supports: Manufacturer's standard structural steel seal welded to tank.
6. Exterior shall be finished shall be manufacturers standard oil resistant enamel or epoxy.
7. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
8. Lifting Lugs: For handling and installation.

D. Day Tank Rupture Basin

1. Provide a rupture basin for the day tanks specified in section 2.9.
2. Manufacturer: subject to compliance with requirements, provide products by one of the following:

    a. Preferred Utilities
    b. Pryco

3. Welded heavy gauge steal structure sized a minimum of 200% capacity of tank capacity.

4. Exterior shall be finished in an oil resistant, textured gray enamel
5. Provide ½" plugged drain connection
6. Provide ¾" connection for leak detector

E. Day Tank Accessories

1. Day Tank Multi-Point Level Switch
   a. The multi-point level switch shall have four (4) float operated switches rated at 100 watts. The switches shall be set and have the following functions:
      1) High-level alarm and pump shutdown (90% capacity)
      2) Pump off (80% capacity)
      3) Pump on (50% capacity)
      4) Low-level/lag pump start (40% capacity).
   b. Unit shall be suitable for pressures to 150 psi and shall be made entirely of non-ferrous material.
   c. Electrical connections shall be contained in a factory installed weatherproof junction box.
   d. Level Control shall be Preferred Model PLS- 4 or equal.

2. Day Tank High-High Level/Vent Overflow Switch
   a. Day tank shall be provided with a vent line switch (shipped loose) to indicate the occurrence of a tank overflow into the vent line.
   b. Switch shall be mounted in a tee connection as close to the day tank as possible. Switch shall be redundant sealed against vapors and fluids, lever float operated and magnetically actuated.
   c. Electrical connections shall be contained in a weatherproof junction box.
   d. Switch shall be as manufactured by Preferred Utilities Mfg. Corp. Model: RBS or equal.

3. Day Tank Leak Switch
   a. Preferred Utilities PLS-1 or RBS or equal as detailed above and based on tank configuration.

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 as manufactured by Preferred Utilities Mfg. Corp., or equal.
5. Day Tank Return Fuel Oil Pump
   a. Return fuel oil pump shall be sized to meet or exceed the total capacity of the supply pump.
   b. Return fuel oil pump shall be mounted to the top or side of the remote day tank. Manufacturer to decided which location is best.
   c. Return fuel oil pump shall have a dedicated tapping within the day tank with a drop tube.
6. Flow Control Manifold

a. Provide a factory assembled flow control manifold consisting of two 120V solenoid valves, two manual shut-off and isolation valves, a manual bypass valve, 40-mesh strainer, and sight flow indicator.
b. The manifold shall be factory assembled, painted, and fully wired into a NEMA 12 junction box.
c. The entire assembly shall be pressure tested to 50 psig
d. The manifold shall be Preferred Utilities FCM-10-S2-S-FI-0-0 or equivalent

2.8 Fuel Oil Filtration System

A. Acceptable manufacturers subject to compliance with the specifications:

1. Preferred Utilities
2. Pall Corporation

B. The filtration system shall be factory assembled with components piped and mounted inside a continuously welded steel enclosure.

1. The enclosure shall be constructed of 14-gauge steel as minimum, continuously welded and constructed to NEMA 4 standards and have an integral 2" steel containment basin with plugged drain options.
2. The basin shall be sized to contain (capture) potential leaks.
3. Doors shall be fully gasketed with a turned edge, full door length piano hinges, and a three-point lockable latching mechanism for security.
4. The enclosure interior shall be primed and finished in a white gloss, chemical resistant enamel.
5. The enclosure exterior shall be primed and finished in durable, chemical resistant, textured gray enamel, suitable for industrial environments.
6. Pipe shall be schedule 40 ASTM A-53 Grade “A” with ANSI B16.3 Class 150 malleable iron threaded fittings
7. Pump and Motor Assembly: An internally mounted, TEFC motor and positive displacement pump with cast iron housing shall be provided. The pump shall be industrial grade and intended for continuous heavy-duty service.
8. Primary Filter: Primary Oil strainer shall have cast iron body, threaded connection; size shall be suitable for the required flow and suitable for working pressures to 150 psi. Clamped cover and handle shall permit easy removal of the basket. Basket shall 100 mesh stainless steel.
9. Secondary Filtration: Multi- purpose filter element shall provide both particulate and water removal. Filtration provided to 5-micron. No special tools required to replace the element.
10. Filter Monitoring: Each filter stage shall have a differential pressure switch piped across them to indicate when the filter (s) require maintenance or replacement.
    a. The differential pressure switch shall provide clear indication of strainer obstruction status with the use of a Tri-Colored Scale Plate with GREEN denoting Clean, YELLOW denoting Change and RED denoting dirty clogged strainer.
    b. The differential pressure switch shall have one-piece cast-iron body and shall be suitable for pressure to 200 psi.
11. Control and Monitoring Hardware.

a. The control strategy shall be a microprocessor-based controller with color touch screen.
b. The control strategy shall be factory configured and stored on an EEPROM and shall be password protected from re-configuration by unauthorized personnel.
c. The controller shall be designed so that it will "fail safe" in the event there is a microprocessor failure.
d. Control hardware shall include a combination magnetic motor starter with overload protection and a circuit breaker. The control system shall provide common alarm dry contacts, to be interfaced with the Building Maintenance System.
e. The system shall be able to communicate to an external controller, building automation system, or energy management system via Modbus RTU, Modbus TCP/IP, or BacNet TCP/IP.

12. Automatic Operation: In order to ensure automatic fuel maintenance for the facility the filtration system shall have an adjustable automatic start and run time set points. The operator shall be able to create a filtration schedule to filter each tank at predetermined intervals. The schedule will be created/edited via the HMI and will be password protected.
    a. The operator will also be able to initiate a filtration cycle selecting a duration, and selecting the "start filter" soft key on the HMI. The operator can also stop the filtration cycle at any time using the "stop filtration" soft key.
13. Leak Detection Switch: Provide a factory mounted Containment Basin Leak Switch.
    a. Switch to be float type and designed to shut down the system and energize an audible and visual alarm should a leak be detected.
    b. The level sensor shall be a plasma welded stainless steel construction.
    c. Electrical connections shall be contained in a factory installed weatherproof junction box.
14. Alarms shall include at a minimum:
    a. Pump failure
    b. Basin Leak detected
    c. High Filter Differential Pressure
    d. Filter Saturated
    e. Filter High Water Level
15. Operator Interface: All operator interface components shall be door mounted. As a minimum, the following devices, control switches and pushbuttons shall be provided:
    a. Human Machine Interface (HMI): The HMI interface have a 4.3" touch screen TFT display with full 256-color support. At a minimum the following will be displayed on the HMI:
        1) Pump On indication
        2) Pump run time
        3) And the following alarms, "Filter Saturated", "Filter Water Level High" and "System Basin Leak Detected".
    b. Alarm Silence, Manual Reset, Lamp/Alarm Test Pushbuttons
    c. Pump "Hand-off-Auto" control switch
16. Ship Loose Fuel Oil Specialties
    a. Anti-siphon
    b. Lever gate
    c. Foot valve - tank
17. Quality Assurance Inspection, Labeling and Testing

a. The Control Cabinet shall be manufactured and labeled in accordance with UL508A.
b. Simply supplying UL recognized individual components is not sufficient and grounds for rejection. The assembled control must be inspected for proper wiring methods, fusing, etc., and must be labeled as conforming to UL508A. (CSA C22.2 #14 for use in Canada).
c. Inspection and labeling shall be supervised by UL or other approved Nationally Recognized Test Lab (NRTL).

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 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."

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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."

3.11 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.

3.12 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.

3.13 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.

3.14 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.

3.15 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.

3.16 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**."**

3.17 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.

3.18 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.

3.19 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.

3.20 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

TABLE OF CONTENTS
SECTION 233113 – METAL DUCTS

SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Duct Construction and Design Performance Requirements: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment.

C. Duct Construction Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Coordination Drawings: Plans, drawn to 1/4 scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

E. Welding certificates.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Conditioned Space, Exhaust Ducts: Seal Class B.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

G. Horizontal fire-wrap duct support systems shall be constructed using a minimum 3/8” diameter uninsulated all-thread steel rod and 1-1/2” x 1-1/2” x 1/8” uninsulated steel angle spaced a maximum 60” on center along the length of the duct. Steel angle shall be sufficiently long such that a minimum clearance of 1” is achieved between the protected duct and the steel rod. Vertical fire-wrap duct support system shall be constructed using minimum 1-1/2” x 1-1/2” x 1/4 steel angle brackets located on opposite sides of the duct, on the top and bottom of each floor-ceiling assembly. The supports shall be attached to the duct with welds. Maximum spacing between vertical supports shall be established by structural calculations in accordance with the applicable code that are submitted to the building official for approval.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

a. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class. Test must include all duct that will be made inaccessible.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Provide drainage and cleanup for wash-down procedures.
5. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.

C. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

D. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

END OF SECTION 233113

TABLE OF CONTENTS
SECTION 233300 – AIR DUCT ACCESSORIES

SECTION 233300 - AIR DUCT ACCESSORIES

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. Duct-mounted access doors.
2. Flexible connectors.
3. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Wiring Diagrams: For power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches. l

2.2 DUCT-MOUNTED ACCESS DOORS

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

1. Buckley.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.
4. Pottorff; a division of PCI Industries, Inc.
5. Ventfabrics, Inc.
6. Ruskin.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; "Duct Access Doors and Panels," and "Access Doors - Round Duct."

1. Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

a. Access Doors less than 12 inches square: No hinges and two sash locks.
b. Access Doors up to 18 inches square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
d. Access Doors larger than 24 by 48 inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class. Minimum 12 gauge.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 1-inch above normal operating pressure.

5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber. Maximum leakage no more than 7 cfm/FT^2 at 1" w.g.
9. Insulation Fill: 1-inch thick, fibrous-glass or polystyrene-foam board.
10. Springs: Stainless steel.
11. Mounting: Vertical.
12. Size: Per manufacturer's instructions based on application and system operating capacity.

2.3 DUCT ACCESS PANEL ASSEMBLIES

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

1. Flame Gard, Inc.
2. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon, 0.0428-inch stainless steel.

D. Fasteners: Carbon or stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.4 FLEXIBLE CONNECTORS

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches or 5-3/4 inches wide attached to 2 strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

E. Generator Radiator Exhaust System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.5 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Set dampers to fully open position before testing, adjusting, and balancing.

D. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. At outdoor-air intakes and mixed-air plenums.
2. Downstream from control dampers, backdraft dampers, and equipment.
3. At each change in direction and at maximum 50-foot spacing for duct cleaning.
4. Upstream or downstream from duct silencers.
5. Control devices requiring inspection.
6. Elsewhere as indicated.

E. Install access doors with swing against duct static pressure.

F. Access Door Sizes: Sized suitably to allow inspection, adjusting, maintenance, or service for the component requiring access.

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

G. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

H. Install flexible connectors to connect ducts to equipment.

1. Generator Radiator Exhaust Systems: Generator Radiator Exhaust system flexible connector.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.

END OF SECTION 233300

TABLE OF CONTENTS
SECTION 233423 – HVAC POWER VENTILATORS

SECTION 233423 - HVAC POWER VENTILATORS

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. Propeller fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Roof curbs.
6. Fan speed controllers.
7. Special coatings.
8. Manufacturer’s installation instructions including inlet/outlet configuration and required service clearances.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangers and supports 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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

D. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Field quality-control reports.

F. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. 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.

B. AMCA, 211 and 311 Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

D. UL Standards: Up-blast propeller fans shall be UL Listed for smoke control systems.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 PROPELLER FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Acme Engineering & Manufacturing Corporation.
2. Loren Cook Company.
3. Greenheck.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with polyester powder finish coat applied after assembly.

C. Fan Wheel: Extruded aluminum blades keyed and locked with two set screws to cast aluminum hub. Spark resistant construction, AMCA 99, Type A for explosion proof applications.

D. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Fan Drive:

1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend grease fitting to accessible location outside of unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Re-greasable, self-aligning ball bearings.

a. Ball-Bearing Rating Life: ABMA 9, L_{50} of 200,000 hours..

8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
9. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
10. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
11. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:

1. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
2. Wall Sleeve: Galvanized steel to match fan and accessory size.
3. Weathershield Hood: Galvanized steel to match fan and accessory size where indicated on schedule.
4. Weathershield Front Guard: Galvanized steel with expanded metal screen where indicated on schedule.
5. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent on direct drive fans. Factory provided and mounted on unit, unless indicated otherwise.
6. Nonfusible type enclosed switch, mounted to frame of fan, factory wired through an internal aluminum conduit.
7. Vibration Isolators:
    a. Refer to Division 23, “Vibration and Seismic Controls for HVAC Piping and Equipment”.
8. Spark Arrestance Class: A for explosion proof applications.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan cooled in dust environments.

C. Enclosure Type: Open drip proof for general applications.

D. Enclosure Type: Explosion proof motors for all fans located in explosive atmospheres or fans that exhaust explosive atmospheres.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of

Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using. Vibration- and seismic-control devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and. Vibration-control devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install units with clearances for service and maintenance.

F. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

END OF SECTION 233423

TABLE OF CONTENTS

SECTION 235100 – BREECHINGS, CHIMNEYS, AND STACKS

SECTION 235100 - BREECHINGS, CHIMNEYS, AND STACKS

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. Listed double-wall generator exhaust vents.

B. Related Sections include the following:

1. Section 235113 "Draft Control Devices" for induced-draft and mechanical fans and for motorized and barometric dampers.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Listed generator exhaust vents.
2. Guy wires and connectors.

B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
3. Provide detailed shop drawing layout indicating layout requirements. Manufacturer shall provide anchors, guides and expansion joints at change of direction and at vertical riser. Actual stack size shall be verified based on approved equipment, routing and calculations provided with stack submittals. Factory engineered stack shall include all necessary components for a complete and rated system, such as support assemblies, expansion joints, guides, thimble, collars, etc. No stack submittal will be reviewed without calculations.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain listed system components through one source from a single manufacturer.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED GENERATOR EXHAUST VENTS

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

1. American Metal Products; MASCO Corporation.
2. Heat-Fab, Inc.
3. Metal-Fab, Inc.
4. Selkirk Inc.; Selkirk Metalbestos.
5. Van-Packer Company, Inc.

B. Description: Double-wall metal generator exhaust vents tested according to UL 103 and UL 959 and rated for 1400 deg F continuously, or 1800 deg F for 10 minutes; with positive or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 2-inch annular space filled with high-temperature, ceramic-fiber insulation.

D. Inner Shell: ASTM A 666, Type 304 stainless steel.

E. Outer Jacket: 304 stainless steel.

F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.2 GUYING AND BRACING MATERIALS

A. Cable: Three stainless steel galvanized, stranded wires of the following thickness:

1. Minimum Size: 1/4 inch in diameter.
2. For ID Sizes 4 to 15 Inches: 5/16 inch.
3. For ID Sizes 18 to 24 Inches: 3/8 inch.

B. Pipe: Two galvanized steel, NPS 1-1/4.

C. Angle Iron: Two galvanized steel, 2 by 2 by 0.25 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Building-Heating-Appliance Chimneys: Exhaust for engines.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.

B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.

D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.

E. Lap joints in direction of flow.

F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.

G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.

H. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

3.4 CLEANING

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

B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.

C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

TABLE OF CONTENTS
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

TABLE OF CONTENTS
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. Coordinate any interpretation of Contract Documents with the Griffin Healthcare.
    d. Take all reasonable efforts to resolve apparent conflicts in the work, identified in the coordination process, without impact to Design Intent and Project Requirements.
    e. Assist with resolution of apparent conflicts identified by Griffin Healthcare, provided that reasonable efforts by Contractor have been undertaken to first resolve apparent conflict.

2. Griffin Healthcare:

    a. Procurement of ATSs and Essential Equipment Distribution Switchboard as defined within these specifications and outlined on Contract Drawings.
    b. Coordinate any interpretation of Contract Documents with the Contractor.
    c. Take all reasonable efforts to resolve apparent conflicts in the work, identified in the coordination process, without impact to Design Intent and Project Requirements.
    d. Assist with resolution of apparent conflicts identified by Contractor, provided that reasonable efforts by Griffin Healthcare have been undertaken to first resolve apparent conflict.

3. 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 and/or Griffin Healthcare's coordination activities are exhausted.
    c. Review and assistance with resolution of apparent conflicts identified by Contractor and/or Griffin Healthcare, provided that reasonable efforts by both parties have been undertaken to first resolve apparent conflict.
    d. Accept or Reject Contractor's or Griffin Healthcare'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.
5. 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.
6. ings, 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.

B. Outlet boxes for low voltage devices requiring a 1-1/4” stub-up connection to be 4-11/16” square, 3-1/4” deep box. Provide single or two gang box trim ring as required.

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 type FRN-R for 208 V usage, and Bussmann type FRS-R for 480 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

TABLE OF CONTENTS
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

TABLE OF CONTENTS

SECTION 260545
PENETRATION FIRESTOPPING FOR ELECTRICAL

SECTION 260545 – PENETRATION FIRESTOPPING FOR ELECTRICAL

PART 1 - GENERAL

1.1 REFERENCES

A. This Section covers the specification of sleeves and sleeve seals 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.

1.2 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

A. Only tested firestop systems shall be used in specific locations as follows: Penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

1.4 RELATED WORK OF OTHER SECTIONS

A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:

1. Section 21 00 00 - Fire Suppression
2. Section 23 00 00 - Heating, Ventilating, and Air Conditioning (HVAC)

1.5 REFERENCES

A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"

B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Firestops"

C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

1. UL Fire Resistance Directory:

a. Firestop Devices (XHJI)
b. Fire Resistance Ratings (BXRH)
c. Through-Penetration Firestop Systems (XHEZ)
d. Fill, Voids, or Cavity Material (XHHW)
e. Forming Materials (XHKU)

D. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

E. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops."

F. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials."

G. International Building Code

H. NFPA 1 – Fire Code

I. NFPA 101 - Life Safety Code

J. NFPA 70 - National Electric Code

1.6 QUALITY ASSURANCE

A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Firestop System installation must meet requirements of ASTM E 814 or UL 1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.7 SUBMITTALS

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL firestop systems to be used and manufacturer's installation instructions to comply with Division 1.

B. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor's name who will install firestop system as described in drawing.

C. Submit material safety data sheets provided with product delivered to job-site.

1.8 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature limitations.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Scheduling:

1. Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
2. Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.1 FIRESTOPPING - GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Provide a round enclosed fire rated cable management device whenever cable bundles penetrate fire rated walls. The cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type.

D. Penetrations in Fire Resistance Rated Walls: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.

E. Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
2. T-Rating: when penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
3. W-Rating: Class 1 rating in accordance with water leakage test per UL 1479.

F. Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with UL 1479 or ASTM E 814.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at both ambient and elevated temperatures.

G. Mold Resistance: Provide penetration firestoppping with mold and mildew resistance rating of 0 as determined by ASTM G21.

2.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of 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.

2.3 MATERIALS

A. 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.

B. Sealants, foams or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:

1. Hilti Intumescent Firestop Sealant (FS-ONE)
2. Hilti Fire Foam (CP 620)
3. Hilti Flexible Firestop Sealant (CP 606)
4. Hilti Elastomeric Firestop Sealant (CP 601S)

C. 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 (FS-ONE)

D. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:

1. Hilti Intumescent Firestop Sealant (FS-ONE)
2. Hilti Fire Foam (CP 620)
3. Hilti Flexible Firestop Sealant (CP 606)
4. Hilti Elastomeric Firestop Sealant (CP 601S)

E. Non curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:

1. Hilti Firestop Putty Stick (CP 618)
2. Hilti Firestop Plug (CFS-PL)

F. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:

1. Hilti Firestop Mortar (CP 637)
2. Hilti Firestop Block (CFS-BL)
3. Hilti Fire Foam (CP 620)
4. Hilti Firestop Board (CP 675T)

G. Non curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:

1. Hilti Firestop Block (CFS-BL)
2. Hilti Firestop Board (CP 675T)

H. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:

1. Hilti Firestop Block (CFS-BL)
2. Hilti Firestop Plug (CFS-PL)

I. Provide a firestop system with a "F" Rating as determined by UL 1479 or ASTM E 814 which is equal to the time rating of construction being penetrated.

J. Where multiple cables/conduits must penetrate fire-rated construction: seal with through-wall sealing fittings acceptable equivalent to Crouse-Hinds “TW Series Thru-Wall Barrier” or acceptable equivalent by STI “EZ Path” or Wiremold/Legrand “FLAMESTOPPER” with the following provisions:

1. Assemblies shall be complete with mounting frames, sealing block assemblies, plugs, reducers, anchors, and lubricant.
2. Provide sizes and quantities required for application with ample spare capacity or as directed by Architect where provisions are being made for future use by Owner.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify penetrations are properly sized and in suitable condition for application of materials.
2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
5. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate location and proper selection of Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

3.3 INSTALLATION

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration materials.

1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
2. Protect materials from damage on surfaces subjected to traffic.

C. Contractor shall coordinate with Architect or Owner’s code barrier drawings in addition to requirements set forth in IBC, NFPA and UL for specific barrier locations and ratings.

3.4 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.5 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION 260545

TABLE OF CONTENTS
SECTION 260548 – VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 REFERENCES

A. This section covers the specification of vibration isolation and seismic restraint for electrical 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, equipment, services and transportation for vibration and seismic control systems for electrical equipment, conduit, busway, cable tray and other wiring systems as indicated on Contract Drawings and specified herein, including but not limited to following:

1. Vibration control systems.
2. Seismic restraint systems, including equipment bolts and welding.
3. Flexible connections.
4. Equipment bases.

B. Seismic devices shall be by manufacturer with 5 years experience in designing and manufacturing seismic devices.

1.3 DEFINITIONS

A. The 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. Seismic-Restraint Loading:

1. Refer to structural drawings to obtain the seismic design criteria to use for this project in order to calculate the seismic restraint loading for the electrical systems and components. This includes but is not limited to the following:

a. Site Class as Defined in the IBC.
b. Assigned Seismic Use Group as Defined in the IBC.

c. Seismic design category as defined in the IBC.
d. Design Spectral Response Acceleration at Short Periods S_{DS} (0.2 Second).
e. Design Spectral Response Acceleration at 1.0-Second Period S_{D1}.

2. Refer to the Seismic Restraint Schedules in Part 3 for the Component Importance Factor (I_P), the Component Response Modification Factor (R_P) and the Component Amplification Factor (a_P) that apply to this project.

1.5 SUBMITTALS

A. Submit for review shop drawings on every product and material furnished under this Section.

B. Shop drawings shall include:

1. Itemized list detailing electrical systems and components to be seismically restrained, associated seismic restraint system to be used, device loading and reference to specific drawings showing base and construction where applicable. List shall include number and location of seismic restraints and anchors for each piece of equipment.
2. Itemized list detailing electrical systems and components which are to be neither isolated nor seismically restrained.
3. Seismic restraint calculations.
4. Detail drawings on equipment bases including dimensions, structural member sizes, support point locations, maximum loading at each location, and concrete and steel details such as anchor bolt locations.
5. All seismic restraining devices shall have a pre-approved number from California OSHPD or other recognized government agency showing maximum restraint ratings.
6. Detail drawings on seismic restraint systems for conduit, busway, cable tray and other wiring systems, including methods of suspension, support guides, and maximum loading at each location.

C. 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 OSHPD**.**
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.

D. In addition to other requirements for approval of substitutions:

1. Contractor must prove substitute systems meet the deflection and structural design of systems specified.
2. Requests for substitution of "internally isolated" electrical equipment in lieu of specified restraint systems must include certification by equipment manufacturer that equipment supports meet specified seismic restraint criteria. Certification must be sealed by Structural Engineer.

E. Shop drawing for equipment shall include bolt points and diameter of inserts, certified by civil or structural engineer.

F. Submit manufacturer's installation instructions and drawings.

G. Submit final inspection report which includes:

1. Manufacturer's report(s) indicating restraint devices as properly installed or requiring correction. Correction measures shall be detailed.
2. Contractor's report detailing steps taken to properly complete the isolation work.

H. 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. The professional engineer shall have P.E. registration in the state where the project is located.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

    a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.

4. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic 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. Preapproval and Evaluation Documentation: By OSHPD, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

I. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

J. Welding certificates.

K. Qualification Data: For professional engineer and testing agency.

L. Field quality-control test reports.

1.6 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.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SEISMIC RESTRAINT SYSTEMS – GENERAL

A. Systems shall comply with the current approved edition of the International Building Code and with all Federal, State and local requirements.

2.2 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide vibration isolators manufactured by one of the following:

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.
4. Vibration Mountings & Controls, Inc.
5. Korfund Dynamics.

B. Pads: Arrange 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.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Isolators: 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.

D. Restrained Spring Isolators: 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.

2.3 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide seismic bracing kits systems and components by International Seismic Application Technology (ISAT) or a comparable product by one of the following:

1. Amber/Booth Company, Inc.
2. Hilti Inc.
3. Mason Industries.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by OSHPD.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Refer to Paragraph 2.1 above for general requirements. Seismic products shall be as manufactured by Mason Industries (M.I.) as follows:

1. Certified seismic anchor bolt: Type SAB
2. Certified seismic anchor stud: Type SAS
3. Bolt isolation washer bushing: Type HG
4. Panelboard mount: Type PB
5. Seismic cable brace anchor and assembly: Type SLB
6. Seismic cable brace hook anchor assembly: Type SCBH
7. Seismic solid brace swivel anchor assembly: Type SSB
8. Seismic restrained spring mount assembly: Type SLR.

D. Seismic products and systems shall meet the following:

1. 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.
2. Restraint Cables: ASTM A 603 galvanized -steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
3. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Do not weld stiffeners to rods.
4. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
5. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
6. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
7. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
8. Adhesive Anchor: 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.
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-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-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. 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.

B. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by OSHPD.

C. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.

D. 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 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.

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 OSHPD providing required submittals for component.

B. 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.

C. 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.

D. 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 runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

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

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 isolated equipment 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 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Seismic restraint shall be provided on distribution systems. Restraint type shall be as follows:

Normal Power Distribution System	**Seismic Restraint Type**	**Component Importance Factor I_P**	**Component Amplification Factor a_P**	**Component Response Modification Factor R_P**
Conduit	SCB/SSB	1.0	1.0	2.5

1. Individually mounted conduit 2-1/2 inch and smaller or conduit supported by hangers less than 12” do not require seismic restraints.

2. The Component Importance Factor (I_P) shall be 1.5 for all systems installed in an Occupancy Category IV building.
3. The Component Importance Factor (I_P) shall be 1.5 for all distribution system components that make up the emergency and standby power systems.

B. Vibration control and seismic restraint shall be provided on electrical equipment. Device types shall be as follows:

Normal Power System Equipment	**Seismic Restraint Type**	**Component Importance Factor I_P**	**Component Amplification Factor a_P**	**Component Modification Factor R_P**
Panels, switchgear MCC's sheetmetal formed equipment	PB, HG, SAS, SAB	1.0	2.5	6.0
Transformers, Inverters, Batteries, Motors	HG, SAS, SAB	1.0	1.0	2.5
Floor/roof-mounted non-isolated equipment, if not specified elsewhere	HG, SAS, SAB	1.0	2.5	6.0
Wall-mounted non-isolated equipment, if not specified elsewhere	PB	1.0	2.5	6.0
Non-isolated equipment suspended from structure, if not specified elsewhere	SCB, SSB	1.0	2.5	6.0
Floor mounted isolated equipment (i.e. generators) if not specified elsewhere	SLR, SAB, Welded	1.5	2.5	6.0
Emergency and standby system equipment	As specified above for normal power systems equipment	1.5	2.5	6.0

C. Refer to Section 26, "ENGINE GENERATORS" for additional requirements.

3.8 INSPECTION

A. Furnish services of structural engineer with P.E. registration in the state in which the project is located, to review the system, to inspect the completed system and to verify that there are no isolation short circuits in equipment mounting/bases, isolators or seismic restraints. Engineer shall furnish written certification on installation.

END OF SECTION 260548

TABLE OF CONTENTS
SECTION 260560 – ELECTRICAL TESTING

SECTION 260560 - ELECTRICAL TESTING

PART 1 - GENERAL

1.1 REFERENCES

A. This section covers the specification of testing for electrical 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 SUMMARY

A. This Section includes general requirements for electrical field testing and inspecting. Additional detailed requirements are specified in each Section containing components that require testing.

B. General requirements include the following:

1. Qualifications of testing agencies and their personnel.
2. Suitability of test equipment.
3. Calibration of test instruments.
4. Coordination requirements for testing and inspecting.
5. Reporting requirements for testing and inspecting.

C. A qualified Testing Agency is to be engaged to perform the required testing.

D. All corrections, replacements, repairs so that final testing report describes all equipment “as-left” as acceptable is to be provided.

1.3 QUALITY ASSURANCE

A. Testing Agency Basic Qualifications: Each Section containing electrical testing may include additional requirements from that specified below.

1. Testing Organization:

a. The testing organization shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated.
b. The testing organization shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
c. The testing organization shall use technicians who are regularly employed for testing services.

d. An organization having a designation of NETA Accredited Company issued by the InterNational Electrical Testing Association meets the above criteria.
e. The testing organization shall submit appropriate documentation to demonstrate that it satisfactorily complies with these requirements.

2. Testing Personnel:

a. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
b. Technicians shall be certified in accordance with ANSI/NETA ETT-2010, Standard for Certification of Electrical Testing Technicians. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

B. Test Equipment Suitability: Comply with ANSI/NETA Standards for Acceptance Testing as outlined in Section 5.

C. Test Equipment Calibration: Comply with ANSI/NETA Standards for Acceptance Testing as outlined in Section 5.

D. Acceptance Testing of Electrical Systems: Minimum Standard – Compliance with current Edition of ANSI/NETA Standards for Acceptance Testing as outlined in Section 7.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 GENERAL TESTS AND INSPECTIONS

A. If a group of tests are specified to be performed by an independent testing agency, prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for independent agency testing. Include the following minimum preparations as appropriate:

1. Perform insulation-resistance tests.
2. Perform continuity tests.
3. Perform rotation test (for motors to be tested).
4. Provide a stable source of single-phase, 208/120-V electrical power for test instrumentation at each test location.

B. General Wiring Tests

1. Prior to final inspection and tests: wiring and connections shall be completed, devices and equipment shall be properly operating, power and lighting circuit and control wiring shall be clearly identified with acceptable tags, and lighting fixtures shall be installed, ready for acceptance.

2. Before devices or equipment is energized, test each wiring system for the following:

   a. System is free from short circuits.
   b. System is free from ground faults.
   c. System is at or below 600 V shall have a minimum installation resistance of 100 megohms when tested with 1000 VDC potential between conductors and between conductors and ground, for a minimum of one minute at 70°F ambient air temperature and dry atmosphere (below 55% RH).
   d. Grounding paths have been visually confirmed and acceptable maximum resistance to earth tested.

C. Overcurrent Protective Device Setting

1. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment to perform or supervise the adjustment of settings on overcurrent protective devices within equipment.
2. Testing: Perform the following device setting and prepare reports:

   a. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

      1) Verify that overcurrent protective devices meet parameters used in studies.
      2) Adjust devices to values listed in study results.

3. Adjust devices according to recommendations in ANSI/NETA Standards for Acceptance Testing as outlined in Chapter 7, and Tables 10.7 and 10.8 in Standard.

D. Motor Tests

1. After systems are balanced and ready to be turned over to the Owner, test and report motor performance data for motors.
2. Include the following information in the test report:

   a. Equipment name and/or number.
   b. Manufacturer’s nameplate data, including RPM, horsepower, Volts, full-load amperes per phase, service factor, power factor, manufacturer’s name, motor type and model number.
   c. Motor test data, including amperes for each phase, average amperes and phase-to-phase voltage at motor, starter or disconnect switch terminals.

d. Percentage of: (average load test amperes) divided by (nameplate full-load amperes).
e. Size, number and ampere rating of overload heaters. Manufacturer's motor starter heater table.
f. Breaker and disconnect switch data, including size and manufacturer of switches and fuses and branch circuit wiring.

E. Operational Tests

1. Each piece of electrical equipment, including lighting fixtures, motors and controls shall be operated continuously for minimum test period of one hour.
2. Demonstrate by operating equipment that circuits and devices are in good operating condition. Each item of control equipment shall be operated minimum of five times. Demonstration shall be performed after wiring tests.

F. Mechanical System Adjustment and Testing

1. Be present during adjustment period and final testing of mechanical systems. Take readings necessary to ensure that electrical systems are operating properly. Tests for mechanical work are detailed under DIVISION 23, MECHANICAL WORK.
2. Take ampere readings at each electrical component, such as motor and heating coil, to determine proper operation.
3. Record readings and submit them in triplicate to Engineer for review.

G. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer's written testing and inspecting instructions.
2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
3. Tabulation of expected measurement results made before measurements.
4. Tabulation of "as-found" and "as-left" measurement and observation results.

END OF SECTION 260560

TABLE OF CONTENTS
SECTION 260574 – OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD ANALYSIS

SECTION 260574 - OVERCURRENT PROTECTIVE DEVICE COORDINATION AND ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 REFERENCES

A. This section covers the specification of overcurrent protective device coordination and arc flash hazard analysis. 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 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices and an Arc Flash Hazard Analysis.

1. Prepare a fault-current and coordination study and an Arc Flash Hazard Analysis for all new electrical equipment and overcurrent devices to be installed under this project to assure proper equipment and personnel protection. The study shall include normal and essential system components for the new equipment only. This will require that maximum available fault current utility levels are used to calculate the available fault current and arc flash energy levels at the new equipment (i.e new distribution switchboards, new panelboards, new transfer switches, etc).

2. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the utility and the on-site generator sources. The study shall reflect the operation of each device during normal and abnormal current conditions.

3. Provide study reports with Professional Engineer’s seal verifying calculations. Certification shall be by a Professional Electrical Engineer with P.E. registration in the state in which the project is located. One copy is to have live seal. The remaining copies may have photocopies of the Engineer’s seal.

B. Arc Flash Hazard Labels generated from this Study are to be laser printed and permanently affixed to all electrical distribution equipment. Labels shall be standard format, self-adhesive vinyl and be of sufficient durability to withstand cleaning and the environment where they are installed.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:

1. Coordination-study input data, including completed computer program input data sheets.
2. Fault-current and coordination-study report.
3. Equipment evaluation report.
4. Setting report.
5. Arc Flash Hazard Analysis results report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise testing specified in Part 3.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

B. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:

1. EDSA Micro Corporation.
2. SKM Systems Analysis, Inc.

C. Computer Software Developer: Subject to compliance with requirements, provide computer software program by SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399, Table 7-4.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.
c. Explicit negative sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 FAULT-CURRENT STUDY

A. Source Impedance: Utility company's fault-current contribution.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with the following:

1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
2. Low-Voltage Fuses: IEEE C37.46.
3. Circuit Breakers: IEEE C37.13.
4. High Voltage Breaker: IEEE C37.06 and C37.11.
5. Switchgear Assemblies: IEEE C37.20.

E. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system one-line diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

G. Available Short-Circuit Current Field Marking:

1. Legibly mark the following electrical equipment and devices in the field with the maximum available short-circuit current at the device line terminals. The Field Markings shall include the date the short-circuit calculation was performed and be of sufficient durability to withstand the environment involved. The short-circuit levels may be included on the adhesive labels required as part of the Arc Flash Hazard Analysis Study.

EQUIPMENT REQUIRING FIELD MARKED SHORT-CIRCUIT LEVELS

ITEM	NEC 2017 ARTICLE	DESCRIPTION
1.	700.5.E	Automatic Transfer Switches.
2.	701.5.D	Automatic Transfer Switches.
3.	702.5	Automatic Transfer Switches.
4.	430.99	Motor Control Centers
5.	440.10.B	Motor Controllers and Combination Load Equipment

3.3 COORDINATION STUDY

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical distribution system one-line diagram showing the following:

a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.

b. Circuit-breaker and fuse-current ratings and types.
c. Relays and associated power and current transformer ratings and ratios.
d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
e. Generator kilovolt amperes, size, voltage, and source impedance.
f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
g. Busway ampacity and impedance.
h. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.
b. Magnetic inrush current overload capabilities of transformers.
c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Ratings, types, and settings of utility company's overcurrent protective devices.
e. Special overcurrent protective device settings or types stipulated by utility company.
f. Time-current-characteristic curves of devices indicated to be coordinated.
g. Manufacturer, frame size, interrupting rating in amperes RMS symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes RMS symmetrical.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

D. Comply with IEEE 242 recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

G. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between series devices, including power utility company's upstream devices. Show the following specific information:

   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

3. Completed data sheets for setting of overcurrent protective devices.

3.4 ARC FLASH HAZARD ANALYSIS STUDY

A. Provide an Arc Flash Hazard Analysis of the electrical distribution system. The Arc Flash Hazard Analysis will include the following:

1. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for project and use approved computer software program to calculate values. Include studies of system-switching configurations and alternate operations that could result in maximum hazard levels.
2. Perform calculations based on compliance with NEC 110.16, OSHA, NFPA 70E and IEEE 1584 standards.
3. Perform calculations of the potential incident energy that someone can be exposed to at the equipment locations during a fault event.

4. Determine incident energy hazard levels to determine the proper PPE (personal protective equipment) required.
5. Specify the limited approach, restricted approach and prohibited approach boundaries for the maximum hazard levels.
6. Provide PDF files ready for printing of equipment labels for each equipment identifying the above information.
7. Provide printed adhesive labels to attach to each piece of equipment included in the analysis detailing the above hazard information.
8. Provide a summary table of all equipment included in the analysis.
9. Document results of the analysis in a report format, which will summarize the results of the analysis, incident energy, and define approach boundaries for all equipment analyzed.

B. Print and install Arc Flash Hazard Labels on all electrical distribution equipment. Provide in accordance with NFPA 70 and 70E, latest edition.

3.5 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

B. Testing: Engage a qualified testing agency to perform the following device setting and to prepare test reports.

C. Testing: Perform the following device setting and prepare reports:

1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:

   a. Verify that overcurrent protective devices meet parameters used in studies.
   b. Adjust devices to values listed in study results.

2. Adjust devices according to recommendations in current Edition of ANSI/NETA Standards for Acceptance Testing as outlined in Chapter 7, and Tables 10.7 and 10.8 in NETA ATS.

END OF SECTION 260574

TABLE OF CONTENTS
SECTION 262400 – SERVICE AND DISTRIBUTION

SECTION 262400 - SERVICE AND DISTRIBUTION

PART 1 - GENERAL

1.1 REFERENCES

A. This Section covers the specification of secondary electrical service and distribution 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 secondary electrical service and distribution systems as indicated on Contract Drawings and specified herein, including but not limited to following:

1. Switchboards
2. Interior dry type distribution transformers
3. Lighting and power panelboards
4. Fusible branch circuits panelboards
5. Fuses and circuit breakers
6. Surge Protection Device (SPD)

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain each type of switchgear and associated components through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 SUBMITTALS

A. Specifications Compliance: A complete copy of this switchgear specification with each subparagraph noted with the comment, “compliance”, “deviation”, or “alternate”. In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.

1. By noting the term “compliance”, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
2. By noting the term “deviation”, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
3. By noting the term “alternate”, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. An alternate shall be fully described as to what the manufacturer proposes to provide.

B. Submit for review shop drawings on following:

1. Switchboard
2. Circuit Breaker Branch Panelboard
3. Fusible Branch Circuit Panelboard
4. Transformer
5. Circuit breakers
6. Surge Protective Device (SPD)

C. Submit a complete breaker/fuse coordination study for the new electrical distribution system as described here-in. Include time-current curves for breakers and fuses with shop drawing submittals for review. Acceptance of system components will be contingent upon demonstrated achievement of selective coordination for all new distribution equipment. Coordination shall be performed back to, and including, the first existing overcurrent protective device upstream of the point of connection for new work in the Normal systems, and Essential Systems per NEC Articles 240, 620 (elevators) 700 and 701. Refer to NEC Article 517 for Health Care applications.

D. Manufacturer Seismic Qualification Certification: Submit certification that equipment specified in this section will withstand seismic forces. Including the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Submit test report, for review by Engineer.

1.5 STANDARDS

A. Work of this Division shall conform to following standards, as applicable:

1. NEMA Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
2. NEMA Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or less.
3. NEMA Instructions for Safe Handling, Installation, Operation and Maintenance of Busway and Associated Fittings.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS – GENERAL REQUIREMENTS

A. Switchboard shall be front connected, front accessible and sections rear aligned. Switchboard shall have UL label and shall meet UL enclosure requirements. Provide NEMA 1 enclosure for switchboard unless otherwise specified. Switchboard shall be Square D Power-Style QED or acceptable equivalent by ABB or Eaton Corporation**.**

B. Switchboard shall be dead-front with steel channel supports bolted to rigidly welded framework of code gauge steel, supporting cover plates, bussing and components. Paint finish shall be ANSI #49 medium light gray.

C. Switchboard assembly and components shall comply with IBC Seismic Design Category “D” and remain fully operational after the seismic event.

D. Each switchboard section shall have open bottom and individual removable top plate, for installation and termination of conduit. Wireway front covers shall be hinged, permitting easy access to branch circuit breaker load-side terminals.

E. Switchboard bussing shall be of sufficient cross-sectional area to meet UL #891 on temperature rise. Through bus shall be plated copper with full ampacity rating carried through all sections. Through bus supports, connections and joints shall be bolted with hex head bolts and Belleville washers. Through bus shall have provisions for addition of future sections.

F. Unless otherwise noted, vertical distributing bus shall be full capacity, matching through bus.

G. Arc Energy Reduction:

1. Provide an energy-reducing maintenance switch with local status indicator for all breakers rated 1200 Amp or higher or that can be adjusted to 1200 Amp or higher.

a. The maintenance switch shall override the coordinated trip settings that may cause a delay in breaker opening during a fault condition while service is being performed on the breaker or distribution sections of the switchboard. The resulting faster breaker opening time will lower the potential arc flash energy available.
b. Also, provide additional means to reduce clearing time and provide arc energy reduction.

1) Zone selective interlocking.

2.2 ESSENTIAL SYSTEM DISTRIBUTION SWITCHBOARD - EQESBB

A. Procured by Griffin Healthcare and furnished to Contractor for installation.

B. Refer to Paragraph 2.1 above for General Requirements of Switchboard construction and components.

C. For switchboards specified to distribute generator power, each section shall have open bottom and individual removable top plate, for installation and termination of conduit. Wireway front covers shall be hinged, permitting easy access to branch circuit breaker load side terminals. Each distribution section shall be vertically compartmentalized (both breaker and cable spaces) by steel partitions such that breakers and load side feeders from separate distribution sections do not share the same space or compartment. Compartments serving Life Safety, Critical and Equipment loads shall be isolated from each other and shall not feed loads other than those distributed from their specific compartment. Where horizontal compartmentalization is specified on the drawings, cable space for each compartment shall extend from the top and bottom of each distribution section without sharing the cable space from another compartment in that section.

1. Provide main service protector Surge Protection Device (SPD) for generator switchboards that contain components of the Life Safety, Critical and equipment power distribution systems.

D. Distribution Switchboard Arrangement:

1. Incoming Cable Section

2. Owner Power Metering System (via Shark Meter (or equal by SATEC)

a. All Distribution Feeders

3. SPD Protection

    a. Internally mounted in Switchboard

4. Distribution Section

    a. Feeder Circuit Breakers: Group mounted (as scheduled) molded case circuit breakers, totally front accessible, mounted to permit maintenance and testing without reaching over any line-side bussing. Circuit breakers shall be removable by disconnection of only load-side cable terminations; line- and load-side connections shall be individual to each circuit breaker. Each circuit breaker shall have "push-to-trip" button.
        1) Circuit breakers shall have a short circuit current rating of 25,000 Amperes RMS symmetrical.
        2) Circuit breaker trip system shall be a MICROLOGIC electronic trip unit.
        3) All trip units shall be removable to allow for field upgrades.
        4) Trip units shall incorporate “True RMS Sensing”, and have LED long-time pick up indications.
        5) MICROLOGIC trip unit functions shall consist of adjustable long-time pickup and delay, adjustable short-time pickup and delay and instantaneous. Ground fault pickup and delay indication only shall be provided if the main device has the ground fault function, or for any breaker rated 1000 amperes or greater.
    b. Other breakers shall be Group Mounted Devices.

5. Device Locking Provisions:
    a. Provide capability to receive up to three (3) padlocks to lock breaker in the open position and positively prevent unauthorized closing of breaker contacts.

6. Expansion Provisions

    a. Spare Branch Devices: As indicated on plans and details
    b. Space & Provisions: As indicated on plans and details
    c. Bussed for installation of future distribution section

E. Arc Energy Reduction:
1. Provide an energy-reducing maintenance switch with local status indicator for all breakers rated 1200 Amp or higher or that can be adjusted to 1200 Amp or higher.

    a. The maintenance switch shall override the coordinated trip settings that may cause a delay in breaker opening during a fault condition while service is being performed on the breaker or distribution sections of the switchboard. The resulting faster breaker opening time will lower the potential arc flash energy available.

b. Provide alternate means to reduce clearing time and provide arc energy reduction.

1) Zone selective interlocking.
2) Differential delaying.
3) Energy reducing active arc flash mitigation system.

F. Distribution Switchboard, as a complete unit, including main, and feeder devices shall have single short circuit current rating as listed on plans, but not less than 25,000 Amps RMS symmetrical, unless otherwise noted, established by actual tests which meet UL specifications and were made on switchboard of similar construction. Series ratings are not acceptable.

2.3 SURGE PROTECTION DEVICE (SPD)

A. Procured by Griffin Healthcare as part of Essential Equipment Distribution Switchboard and furnished to Contractor for installation.

B. 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:

1. Advanced Protection Technologies Inc. (APT).
2. Eaton Corporation.
3. General Electric Company.
4. Schneider Electric, SQ D Company.
5. Cooper Bussman.

C. Provide SPD mounted in, on or adjacent to the main service and distribution switchboards.

D. SPD shall be a hybrid high-energy power conditioning filter which incorporate transient voltage surge suppression (TVSS) and high frequency electrical line noise filtering.

E. Internal wiring and busing shall be copper. SPD shall include:

1. Field connection mechanical lugs for each phase, neutral and ground; as applicable. Lugs shall accommodate up to #2 AWG copper conductor.
2. Integral disconnect switch.
3. Unit status indicator.
4. Integral diagnostic test point.
5. NEMA 1 enclosure.
6. Form C dry contacts for connection to Building Management System which shall monitor on-line status of unit.
7. Disturbance counters: Two solid-state, six digit LCD indicators that discriminate between and exhibit both common-mode (L-G) and normal mode (L-N or L-L) disturbances. Counters shall use self-contained lithium batteries, with nominal 10 year life. Reset function shall be secure, remotely located.
8. Selenium enhanced surge protection.

F. Coordinate system voltage, poles and wiring configuration with each application.

G. Provide combination TVSS Protector and Lightning Surge Protector, SPD – Type 1, per UL 1449 – 3rd Edition.

1. Minimum Performance Criteria:

a. 200 kA Surge Rating per mode and 400 kA rating per Phase
b. 20 kA Nominal Discharge Surge Current Rating in conformance with UL-96A

2. Mounted external to main switchboard and within 10ft of bus connection OR mounted integral to main switchboard in a separate, barriered compartment with hinged access panel for service
3. Provide OCP device and size as recommended by manufacturer.

2.3 DISTRIBUTION TRANSFORMERS

A. General Requirements:

1. Transformers shall be 3-phase 2-winding dry type transformers. Transformers shall have 480 V delta primary with two 2-1/2% ANFC and four 2-1/2% BNFC taps to 208Y/120 V secondary. Transformers shall comply with DOE 2016 standard for optimum efficiency at 35% load and shall be labeled for EPA Energy Star Program.
2. Transformers shall be totally enclosed and ventilated, rated for 150°C rise type, Energy Efficient transformers by Square D EX Series or acceptable equivalent by Eaton Corporation or General Electric.
3. Core of transformer shall be visibly grounded to enclosure, by flexible grounding conductor sized per NEMA, IEEE and ANSI standards.
4. Transformers shall be bottom wired to avoid heat transfer to conduit and shall meet NEMA standards for sound level.
5. Transformers shall be labeled with minimum clearances to walls for each side of enclosure.

2.4 PANELBOARDS FOR GENERAL USE

A. Panelboards shall be by Square D. Refer to Contract Drawings for requirements on special ratings and auxiliary devices such as relays, contactors and time switches. Panelboards shall be UL listed and circuit breaker-equipped. Design shall be such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL. Where “space only” is indicated, make provisions for future installation of breaker sized as indicated.

B. Panelboards shall conform to standards of NEMA PB-1. Panelboards shall have distributed phase bussing throughout. Support bus bars on bases independent of circuit breakers. Main buses and back pans shall be designed so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus for connecting grounding conductors; bond to steel cabinet. In addition to equipment grounding bus, provide second “isolated” ground bus, where indicated.

C. Panelboards shall have copper bussing.

D. Each cabinet shall have hinged locking metal door and card holder for directory. All locks shall be fitted to same key. Panelboard card directories shall be completely filled out (typewritten) upon completion of project and shall include source of service. Cover trims for panelboards shall be hinged to box with full height, semi-concealed piano hinges, fastened to box lip with screws, not trim clamps. Door shall be hinged. Trims shall be UL labeled.

E. 208Y/120 V Panelboards: Panelboard shall have main, lugs, branches, and circuit breakers as scheduled. Panelboards shall have a minimum rating of 22,000 A RMS symmetrical interrupting capacity unless scheduled otherwise. Series ratings are NOT acceptable.

1. Lighting and small power panelboards shall be Square D “NQ” with bolt-on breakers or acceptable equivalent.

F. 480Y/277 V and 480 V panelboards: Panelboards shall have main, lugs, branches and circuit breakers as scheduled. Panelboards shall have a minimum rating of 35,000 A RMS symmetrical interrupting capacity unless scheduled otherwise. Series ratings are NOT acceptable.

1. Lighting and small panelboards fed from a 480Y/277 V source shall be Square D, Type NF with bolt-on breakers or acceptable equivalent.

G. Provide bolt-on thermal magnetic-type circuit breakers with interrupting capacity to match panelboard rating. Breaker terminals shall be UL listed as suitable for the type of conductor provided. Multiple circuit breakers shall be a common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phase’s A, B, C, respectively.

H. Ground Fault Circuit Interrupter branch breakers for personnel protection shall be 20A single-pole molded case circuit breakers with neutral pigtail; shall sense current unbalance between branch circuit and its neutral and shall trip upon unbalance; shall be Class “A”, 5 mA sensitivity; and shall be by same manufacturer as panelboards.

I. Ground Fault Circuit Interrupter branch breakers for heat trace cables and other applications requiring other than 4-6mA trip threshold shall be molded case circuit breakers with neutral pigtail in amperage rating and pole configurations required for the application; shall sense current unbalance between branch circuit and its neutral and shall trip upon unbalance; shall be Class "A", 30 mA sensitivity; and shall be by same manufacturer as panelboards.

J. Arc Energy Reduction:

1. Provide an energy-reducing maintenance switch with local status indicator for all breakers rated 1200 Amp or higher or that can be adjusted to 1200 Amp or higher.

a. The maintenance switch shall override the coordinated trip settings that may cause a delay in breaker opening during a fault condition while service is being

performed on the breaker or distribution sections of the switchboard. The resulting faster breaker opening time will lower the potential arc flash energy available.

b. Provide alternate means to reduce clearing time and provide arc energy reduction.

1) Zone selective interlocking.
2) Differential delaying.
3) Energy reducing active arc flash mitigation system.

K. Provide Factory Installed, Integral Surge Protective Devices (SPD) in panels that are part of the emergency power distribution system. The panel shall be labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.

1. 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. Advanced Protection Technologies Inc. (APT).
b. Eaton Corporation.
c. General Electric Company.
d. Schneider Electric, SQ D Company.
e. Cooper Bussman.

2. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

3. Protection modes and UL 1449 -3rd Edition for grounded wye circuits with 480Y/277 V, 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

a. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
b. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
c. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
d. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.

4. Protection modes and UL 1449 -3rd Edition for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

a. Line to Neutral: 700 V.
b. Line to Ground: 700 V.
c. Neutral to Ground: 700 V.
d. Line to Line: 1200 V.

5. SCCR: Equal to 200 kA.
6. Nominal Discharge Surge Current Rating: 20 kA in conformance with UL-96A.

2.5 FUSIBLE BRANCH CIRCUIT PANELBOARDS

A. Fusible Branch Circuit Panelboards (No Branch Circuit Device Over 100 Amp): Cooper Bussmann Quik-Spec Coordination Panelboards; type QSCP or acceptable equivalent by Square D., GE, or Eaton.

B. Fusible Branch Circuit Panelboards (With Branch Circuit Device Over 100 Amp): Square D I-Line/QMB fusible panelboards or equal by GE, Eaton Corporation or Bussmann.

C. Panelboards shall be labeled with a short-circuit current rating of 100,000 Amperes RMS symmetrical or as otherwise indicated on the associated schedules or drawings. Series ratings are NOT acceptable.

D. Non-service entrance rated panelboards shall be UL and cUL Listed. Service entrance rated panelboards shall be UL Listed.

E. Panelboards shall be rated for system voltages up to 600Vac/125Vdc and have a current rating as indicated on the associated schedules or drawings.

F. Panelboard overcurrent protective device interrupting ratings shall be fully rated for the maximum available fault current noted on drawings with a minimum of 100,000 amperes. Series ratings are NOT acceptable.

G. Current ratings, configuration of poles and number of circuits shall be as shown on associated schedules or drawings.

H. Interiors shall be factory assembled and shall include the following:

1. Panelboard shall be equipped with a six-space spare fuse compartment for storing replacement branch circuit fuses. Spare fuse compartment shall be located behind locking panel door.
2. Bus bars shall be tin-plated copper with sufficient cross sectional area to meet UL 67 temperature rise requirements.
3. 200A/400A rated neutrals shall be standard, 400A or 800A rated neutral shall be provided where indicated in the associated schedules or drawings. Bonded neutral shall be provided where specified in associated drawings.
4. Provide separate ground bus identified as equipment grounding bus for connecting grounding conductors; bond to steel cabinet. In addition to equipment grounding bus, provide second “isolated” ground bus, where indicated.
5. Main lug conductor terminations:

    a. MLO terminations shall be rated for 60/75°C, Cu-Al
    b. Main terminations shall be rated for 75°C, Cu Only

6. NEMA 1 panelboards shall be field convertible for top or bottom incoming feed. NEMA 3R panelboards are bottom feed only.
7. Permanently installed lockout means shall be provided on the main disconnect for lockout tagout procedures.

8. Main disconnect shall be quick-make, quick-break type.

I. Branch fused disconnects shall be UL and cUL Listed 600Vac/200kA or 125Vdc/100kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.

1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.
2. Device shall provide open fuse indication via permanently installed neon indicating light.
3. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
4. Devices shall have bolt-on style bus connectors.
5. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
6. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A & 100A.
7. Branch circuit overcurrent protection shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR finger-safe fuse with Class J* performance characteristics equal to Bussman Type TCF.
8. Main overcurrent protective devices shall be 600Vac UL Listed minimum 300kA IR and CSA Certified minimum 200kA IR Class J time-delay fuses or Class J* performance fuses equal to Bussman Type JKS.
9. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA.

J. Provide NEMA 1 enclosure surface or flush mount as indicated in associated schedules or drawings. NEMA 3R enclosures shall be surface mount only.

1. Boxes shall be a nominal 20 inches wide and 5-¾ inches deep with wire bending space per the National Electrical Code.
2. Panelboard trim shall be door-in-door type hinged to box and shall be supplied with lockable door covering all disconnect handles and shall be dead-front construction covering all energized parts. Front trim shall be lockable. All lock assemblies shall be keyed alike with like NEMA rated enclosures
3. Enclosures shall be NEMA Type 1 or Type 3R as indicated in associated schedules or drawings.
4. Panelboard card directories shall be completely filled out (typewritten) upon completion of project and shall include source of service.

K. Provide Factory Installed, Integral Surge Protective Devices (SPD) in panels that are part of the emergency power distribution system. The panel shall be labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.

1. 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. Eaton Corporation.
b. Schneider Electric, SQ D Company.
c. Cooper Bussman.

2. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

3. Protection modes and UL 1449 -3rd Edition for grounded wye circuits with 480Y/277 V, 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

a. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
b. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
c. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
d. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V.

4. Protection modes and UL 1449 -3rd Edition for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

a. Line to Neutral: 700 V.
b. Line to Ground: 700 V.
c. Neutral to Ground: 700 V.
d. Line to Line: 1200 V.

5. SCCR: Equal to 200 kA.

6. Nominal Discharge Surge Current Rating: 20 kA in conformance with UL-96A

2.6 ENCLOSED CIRCUIT BREAKERS

A. Enclosed circuit breakers shall be SQD, molded case type that comply with UL 489 and NEMA AB1 and AB3 requirements and shall include Micrologic LSI trip units or equivalent by Siemens or Eaton Cutler Hammer. LSIG trip units shall be provided for breakers rated 1,000 amperes or above at 480/277 volts with ground fault indication if part of the emergency or legally required standby power systems. Instantaneous must have high setting of at least 15 times LTPU or the capability to be turned off. Trip settings shall be set per coordination study. Trip units shall be removeable to allow for field upgrades and incorporate “True RMS Sensing” and have LED pickup indications.

1. Enclosures for circuit breakers shall meet NEMA 250 requirements. Indoor locations shall be NEMA 250 Type 1. Outdoor and kitchen locations shall be NEMA 250 Type 4X stainless steel. Enclosures shall include external operating handles that are pad-lockable in either the ON/CLOSED or OFF/OPEN position.
2. 480 volt circuit breakers shall be rated for 65,000 A RMS Symmetrical fault current rating and 208 volt breakers shall be rated for 22,000 A RMS Symmetrical.
3. Provide handle padlock device for enclosed circuit breakers.
4. Where electrically operated release or shunt trip devices are specified, the enclosed circuit breaker shall include a control power transformer, with primary and secondary

fuse protection, powered from the line side of the switch or circuit breaker. Provide terminal strip for connection of all external control circuit wiring.

5. The breakers that feed any ATS shall provide the transfer switch with a WCR of 50,000 Amp RMS symmetrical.

2.7 CIRCUIT BREAKERS FOR EXISTING PANELBOARDS

A. All new circuit breakers installed in existing panelboards shall match existing in style, manufacturer and interrupting rating for panel in which they are being installed, unless noted otherwise.

PART 3 - EXECUTION

3.1 GENERAL

A. The Electrical Contractor shall ensure that no piping, ductwork, leak protection apparatus or other equipment foreign to the electrical trade passes through the space equal to the width and depth of the electrical distribution equipment and extending from the floor to the structural ceiling.

3.2 INSTALLATION

A. Install equipment with manufacturer-recommended clearances and NEC-required clearances.

B. Install switchboards and other floor mounted equipment on concrete bases. Concrete bases shall be 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no less than 6 inches (150 mm) in all directions beyond the maximum dimensions of equipment, unless otherwise indicated or required for seismic anchor support.

1. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of 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.

3.3 SPECIAL CLEANING

A. Perform vacuum cleaning and wiping down of bus bars, bus bracing and supports in panelboards, internal enclosure base in motor control centers, and electrical equipment enclosures. (Refer to cleaning requirements specified under DIVISION 1.)

B. Check bus connections and tighten bolts in panels within work areas, in accordance with manufacturer's torque requirements.

3.4 IDENTIFICATION

A. Provide nameplates and general identification as required under SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL WORK, and under DIVISION 1, and as follows.

B. Panelboard nameplate shall include following information:

1. Panelboard reference number.
2. Source panel reference, including circuit breaker supplying panelboard.
3. Location of source panel by building, floor level and room number.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trips.

C. Panelboard Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure during periods of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time acceptable to Owner. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 TESTING

A. Acceptance testing for electrical equipment, 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 Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Testing procedures shall be as described in INETA "Acceptance Testing Specifications" (ATS).

D. Obtain circuit breaker and relay characteristic curves from manufacturer, prior to testing, and furnish copies to Architect.

E. Testing firm shall ensure busway system joint tightness, phasing and insulation resistance by test prior to energizing the system for the first time. Joint resistance shall be evaluated by a qualified person using equipment identified for the specific function. A written record of these tests shall be made available to the authority having jurisdiction.

F. Testing firm shall notify switchgear manufacturer in advance of dates on which acceptance tests will be performed so that manufacturer's representative may be present.

G. Testing firm shall immediately notify Contractor and Engineer, of any deficiencies requiring correction before switchboard is placed in service and shall confirm information in writing within five days.

H. Discrepancies found shall be corrected by firm which installed switchboard. However, testing firm shall make minor field adjustments that may be found necessary.

I. Testing scope shall include the following per current Edition of ANSI/NETA Standards for Acceptance Testing as outlined in Section 7:

1. Switchboards.
2. Dry type, air cooled low voltage (less than 600 V) transformers rated 112-1/2 KVA and above.
3. Switches, low voltage (less than 600V) that make up the main and feeder devices in a switchboard.
4. Circuit breakers, insulated case/molded case including the following:

    a. All main and feeder devices in switchboards and switchgear.
    b. All circuit breakers that have adjustable, electronic trip units.

5. Ground-fault protection systems including all circuit breakers with ground fault protection. Testing shall also be conducted in accordance with instructions provided with the equipment by the manufacturer.

J. Test report shall include typewritten test results on firm's standard test forms.

3.7 CIRCUIT BREAKER SETTINGS

A. Verify final trip settings for adjustable circuit breaker elements. Instantaneous magnetic settings shall be mid-range, unless otherwise noted.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to electrical equipment according to manufacturer's written instructions, throughout periods when electrical equipment environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 262400

TABLE OF CONTENTS
SECTION 263213 – ENGINE GENERATORS

SECTION 263213 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 REFERENCES

A. This Section covers the specification of Packaged Engine Generators. 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 electrical generation systems as indicated on Contract Drawings and specified herein, including, but not limited to the following:

1. Engine generator sets
2. Unit mounted cooling system
3. Unit-mounted and remote-mounted control and monitoring
4. Performance requirements for sensitive loads
5. Fuel system (fuel supply system and all appurtenances including day tanks provided by Division 23)
6. Starting battery
7. Battery charger
8. Silencer (exhaust system piping provided beyond silencer by Division 23)
9. Remote annunciators
10. Remote stop switches
11. Load banks, radiator mounted
12. Load bank control panel

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 SUBMITTALS

A. Product Data: Include the following:

B. Specifications Compliance: A complete copy of this generator specification with each subparagraph noted with the comment, “compliance”, “deviation”, or “alternate”. In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.

1. By noting the term “compliance”, it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
2. By noting the term “deviation”, it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
3. By noting the term “alternate”, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. An alternate shall be fully described as to what the manufacturer proposes to provide.
4. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
5. Include thermal damage curve for generator.
6. Include time-current characteristic curves for generator protective device.
7. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
8. Include generator efficiency at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
9. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95, 80, 70, and 50 deg F. Provide drawings showing requirements and limitations for location of air intake and exhausts.
10. Include generator characteristics, including, but not limited to kw rating, efficiency, reactances, and short-circuit current capability.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.

1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Detailed, dimensioned plan, elevations and sections for outdoor enclosure. Include sound attenuation data.
3. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
4. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
5. Wiring Diagrams: Power, signal, and control wiring.

D. Welding certificates.

E. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces. Including the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Submit Qualification Data for testing agency; including a sample of a representative Field Quality Control Test Report.

G. Certified summary of prototype-unit test report.

H. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

I. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet performance criteria for sensitive loads.

J. Test Reports:

1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
2. Report of sound generation.
3. Report of exhaust emissions showing compliance with applicable regulations.
4. Field quality-control test reports.

K. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.

L. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 and Division 26 , include the following:

1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

M. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 50 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged generator sets and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

F. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX for welding exhaust-system piping.

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Comply with NFPA 37.

I. Comply with NFPA 70.

J. Comply with NFPA 99.

K. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

L. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

M. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver engine generator set and system components to their final locations in protective wrappings, containers and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

2. All warranty work shall include all parts and labor for the duration of warranty period and shall include provision of temporary generator for the duration of the repair at no additional cost to the Owner.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but not less than one of each.

2. Indicator Lamps: Two for every six of each type used, but not less than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Generators:
   a. Caterpillar; Engine Div.
   b. Kohler.
   c. Cummins.
2. Load Banks:
   a. Avtron.
   b. Simplex.
   c. Professional Power Products.
   d. Loadtec.

2.2 ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

C. EPSS Class: Engine-generator set shall be classified as a Class 96 in accordance with NFPA 110.

D. Induction Method: Turbocharged.

E. Governor: Adjustable isochronous, with speed sensing.

F. Emissions: Comply with EPA Tier requirements.

G. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

H. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

2.3 ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.

C. Output Connections: Three-phase, four wire.

D. Safety Standard: Comply with ASME B15.1.

E. NFPA Compliance:

1. Comply with NFPA 37.
2. Comply with NFPA 70.
3. Comply with NFPA 99.
4. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

F. UL Compliance: Comply with UL 2200.

G. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, and model and serial number of component.

H. Fabricate engine-generator-set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.

I. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

2.4 GENERATOR-SET PERFORMANCE

A. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

1. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

B. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.

C. Steady-State Voltage Modulation Frequency: Less than 1 Hz.

D. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.

E. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

F. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

G. Transient Frequency Performance: Less than 2-Hz variation for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

H. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

I. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, the system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

J. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

K. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.5 SERVICE CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet.

2.6 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
3. Provide fuel cooler to maintain fuel temperature and viscosity during a long period (up to one week) of continuous operation at high load.
4. Provide fuel consumption meter to provide data on fuel consumed during any testing or actual power outage generator operation. The fuel data will be transmitted to the Hospital Facility Wide BMS system to aid in generator running data required by the State of Connecticut DEEP.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity: minimum 1500 Watt.

G. Pipe crankcase ventilation fumes directly into engine intake to burn them and reduce unwanted emissions.

H. Emissions: Engine must be certified to meet the EPA Emissions Limits Alternate Standard for Stationary Emergency Generator Sets.

2.7 ENGINE COOLING SYSTEM

A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

B. Radiator: Rated for specified coolant.

C. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

D. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

E. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

F. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

1. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.8 FUEL SUPPLY SYSTEM

A. Comply with NFPA 30.

2.9 ENGINE EXHAUST SYSTEM

A. Muffler/Silencer: Critical grade low profile exhaust silencer sized as recommended by engine manufacturer and coordinated with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 76 dBA or less.

B. Connection from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe, minimum 18” length from exhaust outlet to muffler with flanged pipe connections.

C. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liner.

2.10 COMBUSTION-AIR INTAKE

A. Description: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

2.11 STARTING SYSTEM

A. Description: 24-V electric, with negative ground and including the following items:

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph in "Service Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: 60 seconds.
4. Battery: Adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
    c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
    d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
    e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
    f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.12 CONTROL AND MONITORING

A. Functional Description: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of the generator set. When mode-selector switch is switched to the on position, the generator set starts. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures

or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Provide minimum run time control set for 5 minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

F. Indicating and protective devices and controls shall include those required by NFPA 110 for a Level 1 system plus additional requirements noted otherwise.

G. The controller shall include the ability to accept programmable digital input signals. The signals may be programmed for either high or low activation using programmable Normally Open or Normally Closed contacts.

1. The controller shall include the ability to operate 16 discrete outputs, integral to the controller, which are capable of sourcing up to 300 mA.

H. Indicating and Protective Devices and Controls:

1. AC voltmeter: dual scale, 0-600V, 2% accuracy, 2-1/2” diameter.
2. AC ammeter: dual scale, 2% accuracy, 2-1/2” diameter.
3. AC frequency meter: dial type.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Engine lube oil temperature.
8. Running-time meter.
9. Ammeter-voltmeter, phase-selector switch(es).
10. Generator-voltage adjusting rheostat.
11. Upper and lower meter scale indicator lights.
12. Auto/Off/Test switch. Test mode shall automatically start unit without interrupting normal electrical supply.
13. Overspeed shutdown device with LED status indicator which lights when overspeed condition has occurred as cause of shutdown.
14. Coolant high-temperature shutdown device with LED status indicator which lights when pre-alarm operating temperature has been reached and stays lit when shutdown occurs.
15. Coolant low-level shutdown device with LED status indicator which lights when low coolant level causes shutdown.

16. Oil low-pressure shutdown device with LED status indicator which lights when pre-alarm oil pressure condition has been reached and stays lit when shutdown occurs.
17. Overcrank shutdown device with LED status indicator which indicates engine has failed to start after 60 second cranking period.
18. Lamp test switch and audible alarm with silencer switch.
19. Low coolant temperature alarm with LED status indicator which indicates failure of block heater.
20. LED status indicator for “switch off”, which indicates when control switch has been placed in “off” position.
21. LED status indicator for “system ready”, indicating no malfunctions detected.
22. Fuel tank derangement alarm.
23. Fuel tank high-level shutdown of fuel supply alarm.
24. Generator overload.
25. Start-stop switch.
26. Overspeed shutdown device.
27. Coolant high-temperature shutdown device.
28. Coolant low-level shutdown device.
29. Oil low-pressure shutdown device.

I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

J. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered elsewhere in Division 26.

K. 12 Volt remote annunciator panel for new generator: with lights, audible alarm, alarm switch and lamp test switch, in accordance with NFPA 110, Level 1, to monitor the following conditions:

1. Line power.
2. Generator power.
3. System ready (in auto position).
4. Alarm switch off.
5. Generator switch off.
6. Emergency stop.
7. Engine high-temperature shutdown.
8. Lube-oil low-pressure shutdown.
9. Overspeed shutdown.
10. Remote emergency-stop shutdown.
11. Engine high-temperature prealarm.
12. Lube-oil low-pressure prealarm.
13. Fuel tank, low-fuel level.
14. Low coolant level.
15. Overcrank shutdown.
16. Coolant low-temperature alarm.

17. Control switch not in auto position.
18. Battery-charger malfunction alarm.
19. Battery low-voltage alarm.
20. Battery high voltage alarm.

L. Remote Alarm Annunciator: Comply with NFPA 99. Labeled LED shall identify each alarm event. Common audible signal shall sound for alarm conditions. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

M. Remote Emergency-Stop Switch: Surface; wall mounted, outside of generator room unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.13 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. General

1. Acceptance of generator overcurrent protective devices will be contingent upon achievement of selective coordination of system including but not limited to elevators per NEC Article 620; Emergency Systems per NEC Article 700 and legally required Standby Systems and components per NEC Article 701.

B. Generator Circuit Breaker: Provide two (2) insulated-case, electrically operated, electronic-trip type; 100 percent rated; complying with UL 489; Sq. De. 2000 Amp Frame, Type NT 65,000 AIC or equal by ABB.

1. Tripping Characteristics: Adjustable long-time pickup and delay, short-time pickup and delay, instantaneous and ground fault pickup INDICATION ONLY. Instantaneous must have high setting (15 times LTPU) or the capability to be turned off.
2. Trip Settings: Matched to generator thermal damage curve as closely as possible.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.
5. Mechanical type lugs sized for feeders shown on drawings on load side of breakers.

C. Generator Protector: Microprocessor-based unit that continuously monitors current level in each phase of generator output, integrates generator heating effect over time, and predicts when thermal damage of the alternator will occur. When signaled by the protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from the load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when the generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.

2. Under single or three-phase fault conditions, regulates the generator to 300 percent of rated full-load current for up to 10 seconds.
3. As the overcurrent heating effect on the generator approaches the thermal damage point of the unit, the protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, Article 700.7(D). Integrate ground-fault alarm indication with other generator-set alarm indications.

E. Provide generator OCPD with one N.C. and one N.O. contact indicating breaker status. This status indication shall signal an alarm to the remote annunciator panel to indicate a “Generator Output Breaker Open” alarm. The remote annunciator panel shall be equipped with a single summary alarm wired to the building BMS system indicating a “Generator Trouble” alarm.

2.14 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1 and specified performance requirements.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

F. Excitation shall use no slip or collector rings, or brushes, and shall be arranged to sustain generator output under short-circuit conditions as specified.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.
2. Provide with under-frequency protection and moisture-resistive protection.
3. Regulation shall be within +/-2% of rated voltage from no load to full load.
4. On application of rated load at rated power factor, instantaneous voltage dip shall NOT exceed 20%, with recovery within one second.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

M. Provide Permanent Magnet Generator (PMG) system.

N. Alternator shall be self-ventilated, one-piece cast aluminum alloy, uni-directional internal fan shall provide high volume, low noise air delivery with broad range, 12-lead reconnectable, four pole rotating field unit.

O. Temperature rise shall be within NEMA MG1-22.40, IEEE and ANSI Standards for standby duty at rated output.

P. Provide front-end mounted junction box for load connections. Junction box shall have space to mount regulator and voltage adjust rheostat inside box and to relocate same to opposite side without unit modification.

2.15 LOAD BANK - INDOOR

A. Description: Permanent, indoor, radiator mounted, remotely controlled, forced-air-cooled, resistive unit capable of providing a balanced 3-phase, delta-connected load to generator set at 50 percent rated-system capacity. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available. Unit shall be the “LBD-series” as manufactured by Simplex, or equal by Avtron.

B. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases.

C. Load-Bank Heat Dissipation: Radiator fan shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of the specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of the resistance elements.

D. Load Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA, Type 1 enclosure within load-bank enclosure, accessible through hinged doors with tumbler locks. Contactor enclosures shall be heated by thermostatically controlled strip heaters to prevent condensation.

E. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and over-temperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall

disconnect load power, control, and heater circuits. Short-circuit devices shall be non-interchangeable fuses with 200,000A interrupting capacity.

F. Remote-Control Panel: Separate from load bank in NEMA, Type 1 enclosure with a control power switch and pilot light, and switches controlling groups of load elements.

G. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising and shall automatically initiate load upon signal from the ATS, and shall automatically disconnect load upon signal from the ATS. During an actual power outage to the building, the load bank shall be automatically disconnected from the generator output.

2.16 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard enamel over corrosion-resistant pretreatment and compatible standard primer.

2.17 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 energy converters.
2. Generator Tests: Comply with IEEE 115.
3. Test Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype shall have been factory tested to demonstrate compatibility and reliability.
4. Test generator, exciter and voltage regulator as a unit.

B. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generators level on concrete base. Extend base no less than 6 inches (150 mm) in all directions beyond the maximum dimensions of equipment, unless otherwise indicated or required for seismic anchor support.

1. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of 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.

C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

1. Verify that electrical wiring is installed according to manufacturer’s submittal and installation requirements in Division 26 Sections. Proceed with equipment start up only after wiring installation is satisfactory.
2. Provide interconnecting wiring between generator and automatic transfer switch(es).
3. Provide interconnecting wiring between generator and remote annunciator panel.
4. Provide interconnecting wiring between generator and BMS to signal the BMS that normal power is lost and the generator will be powering loads.
5. Provide interconnecting wiring between the load bank remote control panel and the load bank contactor enclosure and between the remote control panel and the automatic transfer switches.

E. Electrical Contractor to provide fuel for testing and start-up of the engine-generator. Quantity shall be sufficient to complete testing and start-up, but not less than 4 hours at 100% load.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
2. Connect fuel piping to engines with a gate valve and union.

    a. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems outside the building are specified in Division 23 Section "Fuel Oil Piping."
    b. Diesel fuel piping, valves, and specialties inside the building are specified in Division 23 Section "Fuel Oil Piping."

3. Connect exhaust-system piping to engines.

B. Ground equipment according to Division 26 Section "Electrical Grounding."

C. Connect wiring according to Division 26 Section "Conductors and Cables."

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 IDENTIFICATION

A. Identify system components according to Division 23 Section "Mechanical Identification" and Division 26 Section "Basic Electrical Materials and Methods."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect**,** test and adjust field-assembled components and equipment installation, including connections, and to complete field testing. Report results in writing.

B. The factory-authorized service representative shall perform the following field tests and inspections and prepare test reports: Furnish required materials, equipment and services to perform on-site tests, in presence of Architect and Owner, to demonstrate system operation. Correct defects and re-test system until proper operation is guaranteed. Materials and equipment shall include: temporary power and wiring; temporary cooling; 480 Volt, 1250 KW, infinitely variable, outdoor load bank and operator; monitoring devices; etc.

1. Perform each electrical test and visual and mechanical inspection according to current Edition of ANSI/NETA Standards for Acceptance Testing as outlined in Section 7 (except for vibration baseline test). Certify compliance with test parameters. Tests shall be conducted by applying load (via load bank) to load side of automatic transfer switch or to other load point acceptable to Engineer. Test shall include a minimum of four hours operating at 100% rated load.
2. Perform tests recommended by manufacturer.
3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:

a. Single-step full-load pickup test.

4. Coordinate tests with tests for transfer switches and run them concurrently. There are multiple transfer switches both new and existing that must be individually tested to confirm any one of these transfer switches will start the generators and provide generator power to the load.

   a. Test each transfer switch operation by opening its normal power feeder breaker.
   b. Test all the transfer switches shown on the drawings and include results in test report.

5. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

6. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
7. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.
8. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
9. Exhaust Emissions Test: Comply with applicable government test criteria.
10. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
11. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
12. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels, so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 1.

1. Coordinate this training with that for transfer switches.

END OF SECTION 263213

TABLE OF CONTENTS
SECTION 263600 – TRANSFER SWITCHES

SECTION 263600 - TRANSFER SWTCHES

PART 1 - GENERAL

1.1 REFERENCES

A. This Section covers the specification of transfer switches and related 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.

1.2 PROCURMENT AND INSTALLATION

A. All transfer switches shall be procured by Griffin Healthcare.

B. Griffin Healthcare shall furnish ATS-GEN to Contractor's work site. Contractor shall be responsible for installation of transfer switch ATS-GEN, including coordination of connecting to feeders provided by Griffin Healthcare to a point outside of the Generator Room.

C. Griffin Healthcare is responsible to furnish to the work site and provide installation complete of ATSs ATS-CH1, ATS-CH2, ATS-CH3, ATS-MCCB and ATS-MCCP.

1.3 SCOPE

A. Provide labor, materials, services, equipment and transportation necessary for complete and operational electrical systems as indicated on Contract Drawings and specified herein, including, but not limited to, the following:

1. Automatic transfer switches.
2. Remote monitor and control system.

1.4 SUBMITTALS

A. Specifications Compliance: A complete copy of this transfer switch specification with each subparagraph noted with the comment, "compliance", "deviation", or "alternate". In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.

1. By noting the term "compliance", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
2. By noting the term "deviation", it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.

3. By noting the term “alternate”, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. An alternate shall be fully described as to what the manufacturer proposes to provide.

B. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

C. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Wiring Diagrams: Single-line diagram. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

D. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches, accessories, and components will withstand seismic forces defined in Division 26 Section "Seismic Controls for Electrical Work." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Submit Qualification Data for testing agency; including a sample of a representative Field Quality Control Test

F. Field quality-control test reports.

G. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 and other sections in this specification, include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

C. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

D. Source Limitations: Obtain automatic transfer switches, bypass/isolation switches, non-automatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

F. Comply with NEMA ICS 1.

G. Comply with NFPA 70.

H. Comply with NFPA 99.

I. Comply with NFPA 110.

J. Comply with UL 1008 unless requirements of these Specifications are stricter.

K. Manufacturer Testing

1. During withstand tests, there shall be NO contact welding or damage. Tests shall be performed on identical samples without the use of current limiting fuses. Oscillograph traces across the main contact shall verify that contact separation has NOT occurred. Test procedures shall meet UL 1008. Testing shall be certified by UL or acceptable nationally recognized independent testing laboratory.
2. When conducting temperature rise tests to Paragraph 17.3 of UL 1008, manufacturer shall include post-endurance temperature rise tests to verify ability of transfer switch to carry full-rated current after completing overload and endurance tests.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

2. All warranty work shall include all parts and labor for the duration of warranty period and shall include provision of temporary generator for the duration of the repair at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Contactor Transfer Switches:

a. ASCO Power Technologies, LP.
b. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. The ATS shall be ASCO 7000 Series or Russelectric RTS-03 and shall be ASCO frame “H” rated for 50,000 Amps WCR at 480 Volts when protected by any circuit breaker.

B. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.

C. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Neutral Terminal: Fully rated, switched neutral shall be included for all switches.

F. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

G. Heater: Equip switches exposed to outdoor temperatures and humidity, and other units indicated, with an internal heater. Provide thermostat within enclosure to control heater.

H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

I. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

J. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

K. Surge Protective Device (SPD): Provide factory installed integral SPD in transfer switches that are part of the emergency power distribution system. SPD's shall meet requirements defined in Division 26 Section "SERVICE AND DISTRIBUTION."

1. An SPD is not required if the emergency power system overcurrent protective device that feeds the ATS is protected by an SPD.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation. Manual switch operation shall provide same contact-to-contact transfer speed as the electrical operator and prevent injury to operating personnel.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

G. Programmed Neutral Switch Position: Switch operator has a programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and shall be factory set at 20 seconds. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

2.4 AUTOMATIC TRANSFER SWITCH FEATURES

A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

E. After transfer to normal, engine generator shall operate at no load for 5 minutes.

F. Test Switch: Simulates normal-source failure.

G. Switch-Position Pilot Lights: Indicate source to which load is connected.

H. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

I. Assigned Auxiliary Contact: Single pole double-throw contact to signal elevator controller that elevator(s) are on generator power.

J. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

K. Re-Transfer Inhibit Feature: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Display indicates inhibit status. Transfer switch shall retain automatic operation to transfer to emergency upon loss of normal power, and also to retransfer to normal, if available, and emergency fails, meeting UL 1008.

L. Engine Starting Contacts: Two isolated and normally closed, and two isolated and normally open; rated 10 A at 32-V dc minimum. One set of contacts shall be for permanent generator start circuit and one set of contacts shall be for temporary portable generator start circuit.

M. Load Bank Shutdown Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 120-V ac minimum.

N. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

O. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
2. Push-button programming control with digital display of settings.
3. Integral battery operation of time switch when normal control power is not available.
4. Provide ATS controls for capability for Owner to field program the generator exercise schedule.
5. Provide signals to Load Bank Control Panel to initiate load and to disconnect load.

P. Engine Start Control and Monitoring: The Engine Start Modules installed at each automatic transfer switch and the generator continuously monitor engine start wiring to detect an open circuit or a short circuit which then automatically starts the generator and initiates an alarm.

1. The Engine Start Control and Monitoring Device shall be factory installed ASCO accessory 7ES Model 5101-ATS along with Engine Module Field Kit Model 5101-GEN Kit or approved equivalent.
2. The ATS shall provide continuous monitoring of the entire remote start circuit. Visual and audible annunciation of generator malfunction shall be initiated if the integrity of the start circuit is compromised.
3. There shall be minimum time delay (less than 5 seconds) in annunciation of any compromised condition such as an open or short circuit. A system which annunciates

compromised conditions only after a generator start signal is initiated via a redundant path does not meet the intent of this specification.

4. The detection of a compromised start circuit shall initiate and latch the generator start circuit.
5. Each Generator Engine Start Module shall be field installed, din-rail mounted and accept up to (8) ATS Engine Start. Each channel must have its own dedicated tri-colored status LED.
6. Each Engine Start channel must have its own dedicated switch with ability to enable or disable monitoring function.
7. Engine Start Circuit: One pair, hardwired conductors from each transfer switch to generator for interconnection of Control & Monitoring devices.
8. Coordinate placement of required components within the generator controls with the specified manufacturers.

Q. Load Control System: ASCO Option 30A. If the existing 1250 kw generator should shut down or fail during a utility outage, the controller shall immediately signal all three chiller ATS's and ATS-MCCB and ATS-MCCP to transfer to the programmed neutral position to prevent the new 1250 kw generator from being substantially overloaded.

1. After the five (5) ATS's are transferred to their neutral position, the ATS – GEN shall transfer to its alternate source, which is the new 1250 kw generator.

2.5 REMOTE MONITORING AND CONTROL

A. Provide a monitoring and control system connecting all five (5) new transfer switches being provided in this project.

B. System shall provide at minimum the following functions at a single interface panel to be located as shown on Drawings.

1. Status of each switch, available sources and indication of any alarms.
2. Status of generator system and indication of any alarms.
3. Remote transfer and retransfer control.
4. Remote start / stop generator control.

C. Interface panel to be surface mounted on wall.

D. Provide interconnecting control / network wiring and communication hub as required.

E. All wiring to be run in conduit.

F. Provide ASCO 5300 Series Remote Annunciator System or equal.

2.6 FINISHES

A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.7 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with mounting and anchoring requirements specified in Section 260548 “Vibration and Seismic Controls for Electrical Work."

B. Install transfer switches with manufacturer recommended clearances and NEC required clearances.

C. Install floor mounted transfer switches on concrete bases. Concrete Bases shall be 4 inches high, reinforced, with chamfered edges. Extend base no less than 6 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases.

1. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of 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.

D. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

E. Identify components according to Division 26, Section 260515 "Basic Materials and Methods - Electrical."

F. The Electrical Contractor shall ensure that no piping, ductwork, leak protection apparatus or other equipment foreign to the electrical trade passes through the space equal to the width and depth of the electrical distribution equipment and extending from the floor to the structural ceiling.

G. Install Engine Start Control and Monitoring module field kit in the generator controller and connect to the engine start circuit wiring.

3.2 WIRING TO REMOTE COMPONENTS

A. Provide type and number of cables and conductors to match control and communication requirements of transfer switches as recommended by manufacturer.

B. Provide required interconnecting wiring between generator and transfer switches including load shed, monitoring and other communication requirements.

C. Provide required interconnecting wiring between transfer switches including junction box in elevator machine room to signal elevator controller that elevators are on generator power. Also, wiring to signal elevator controller prior to retransfer to normal power. Coordinate installation and time delay setting with elevator manufacturer.

D. Provide interconnecting wiring from load control system to ATS – GEN and to the three (3) chiller ATS's and to ATS – MCCB and ATS – MCCP.

E. All wiring shall be in EMT raceway, minimum 3/4" unless noted otherwise. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Electrical Grounding."

B. Connect wiring according to Division 26 Section "Basic Materials & Methods - Electrical."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and perform field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each electrical test and visual and mechanical inspection according to current Edition of ANSI/NETA Standards for Acceptance Testing as outlined in Section 7. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages

and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

a. Check for electrical continuity of circuits and for short circuits.
b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
c. Verify that manual transfer warnings are properly placed.
d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b. Simulate loss of phase-to-ground voltage for each phase of normal source.
c. Verify time-delay settings.
d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.
b. Observe reaction of circuit-interrupting devices when simulated fault current is applied at sensors.

6. Perform all tests and documentation as required for system acceptance as specified in NFPA-110.

C. Demonstrate the load control system operates properly to transfer loads from the existing 1250 kw generator to the new 1250 kw generator when the existing is offline.

D. Coordinate tests with tests of generator and run them concurrently.

E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

1. Coordinate this training with that for generator equipment.

END OF SECTION 263600