SPECIFICATIONS

for

STEAM BOILER REPLACEMENT

for

ENERSYS
READING, BERKS COUNTY, PA

HVAC CONSTRUCTION

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JUNE 2020

TABLE OF CONTENTS

BIDDING REQUIREMENTS

SPECIFICATIONS

TABLE OF CONTENTS

TABLE OF CONTENTS

END OF TABLE OF CONTENTS

SCHEDULE OF DRAWINGS

The Drawings, except for revisions, clarification sketches, and supplemental Drawings issued subsequent to award of the Contract, are hereby enumerated as follows:

	Dwg. #	Date
ARCHITECTURAL		
Cover Sheet and Code Review	A-0	07/23/20
1/4" Demolition Plan	A-1	"
1/4" Floor Plan and Details	A-2	"
1/4" Roof Plan	A-3	"
Roof Details	A-3A	"
Wall Sections and Details	A-4	"
Door Schedule and Details	A-5	"
HVAC		
HVAC Level 2 – Area "C" Demolition	H-1	07/23/20
HVAC Level 3 – Area "A" Demolition	H-2	"
HVAC Level 3 – Area "B" Demolition	H-3	"
HVAC Level 3 – Area "C" Demolition	H-4	"
HVAC Level 2 – Area "C"	H-5	"
HVAC Level 3 – Area "A"	H-6	"
HVAC Level 3 – Area "B"	H-7	"
HVAC Level 3 – Area "C"	H-8	"
HVAC Schematic and Boiler Room Layout	H-9	"
HVAC Schedules	H-10	"
HVAC Details	H-11	"
ELECTRICAL		
Electrical Level 2 – Area "C" Demolition	E-1	07/23/20
Electrical Level 3 – Area "A" Demolition	E-2	"
Electrical Level 3 – Area "B" Demolition	E-3	"
Electrical Level 3 – Area "C" Demolition	E-4	"
Electrical Level 2 – Area "C"	E-5	"
Electrical Level 3 – Area "A"	E-6	"
Electrical Level 3 – Area "B"	E-7	"
Electrical Level 3 – Area "C"	E-8	"
Boiler Room Layout – Electrical	E-9	"
Electrical Site Plan	E-10	"
Electrical Overall Building Plan – Level 2	E-11	"
Electrical Overall Building Plan – Level 1	E-12	"

END OF SCHEDULE

SECTION 01 21 00 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for allowances included in the Project.

1. All allowances in this Project shall be considered Labor and Material Allowances.

1.3 DEFINITIONS

A. Allowance is an established scope of work to be included as part of the Project that does not have a specifically-referenced location for the Work to be performed.

1.4 INFORMATIONAL SUBMITTALS

A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.

B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.

1.5 ALLOWANCES

A. Use Allowance only as directed by Architect for Owner's purposes.

1. Do not order Allowance materials without direction from the Architect.

B. Contractor's overhead, profit, and related costs for products and equipment required for the Work of the allowance are included in the allowance. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.

1. Contractor shall expect multiple deliveries will be required for Work associated with allowances.

C. At Project closeout, credit unused amounts remaining in allowances to Owner by Change Order.

1.6 ADJUSTMENT OF ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, Contractor shall maintain a spread sheet of allowances approved for use by the Architect. Contractor shall submit allowance spreadsheet with each Application for Payment when the Contractor is requesting payment for work of an approved allowance.

1. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALLOWANCES

A. GENERAL CONSTRUCTION

ALLOWANCE NO. 1-1: Include cutting and patching of ten (10) 24"x24" access holes in existing gypsum board ceilings as directed by Electrical Contractor.

B. HVAC CONSTRUCTION

The Contractor shall include in its Bid $20,000 as a cash allowance for labor and materials to be used at the Owner’s discretion for unforeseen issues or changes they direct after execution of the Contract. Any unused amount shall be credited to the Owner prior to close out of the Project. In no case shall the Contractor, at its discretion and without express Owner approval, use any of this allowance.

END OF SECTION 01 21 00

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.
2. Alternate prices shall be all inclusive of the cost of materials, work, overhead, profit, bonus, insurances, supervision, administration, time, and any and all other costs in connection therewith for work in place and accepted or omitted as the case may be, and shall hold for the same period as the Bid.

B. Alternates are defined as alternate products, materials, equipment, systems, methods, units of work or major elements of the construction, which may, at Owner's option and under terms established by Instructions to Bidders and in the Contract or Agreement, be selected for the work in lieu of corresponding requirements of Contract Documents. Selection may occur prior to Contract Date, or may, by the Agreement, be deferred for possible selection at a subsequent date. Alternates may or may not change scope and general character of the work substantially. Requirements of this section may be related to, but must not be confused with, requirements of Contract Documents related to Unit Prices, Change Orders, Substitutions, and similar provisions.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
2. Each Alternate price filled in on the Bid Form shall include all costs of related coordination, modification or adjustment required due to any deviations from the Basis of Design or Base Bid product. Costs incurred by other Contractors to incorporate their work into the project due to deviations from the Basis of Design due to the Alternate Bid, shall be incorporated into the Alternate Bid price and will not be borne by the Owner for the Work of that Alternate.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other work of the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. General: The description herein for each alternate is recognized to be incomplete and abbreviated, but implies that each change must be complete for the scope of work affected. Refer to applicable Specification Sections and to applicable Drawings for specific requirements of the work, regardless of whether references are so noted in description of each Alternate. It is recognized that descriptions of Alternates are primarily scope definitions, and do not necessarily detail full range of materials and processes needed to complete the work as required.

B. ALTERNATE H100 – HVAC EQUIPMENT

The Base Bid includes furnishing and installing boilers manufactured by Bryan Boiler. This Alternate shall comprise the total change in cost to furnish and install boilers manufactured by either Fulton or Aerco as indicated on the drawing schedules. Work of this Alternate shall be performed in accordance with applicable requirements of the Contract Documents.

END OF SECTION 01 23 00

SECTION 01 73 29 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of cutting and patching.

B. Related Requirements:

1. Division 02 Section "Selective Demolition" for demolition and removal of selected portions of the building.
2. Individual Specification Sections for specific requirements relating to cutting and patching.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

A. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

    a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.

1.5 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.

a. Bearing and retaining walls.
b. Structural steel.
c. Lintels.
d. Structural decking.
e. Miscellaneous structural metals.
f. Equipment supports.
g. Piping, ductwork, vessels, and equipment.

2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety. Operational elements include, but are not limited to, the following:

a. Primary operational systems and equipment.
b. Fire separation assemblies.
c. Air or smoke barriers.
d. Fire-suppression systems.
e. Mechanical systems piping and ducts.
f. Control systems.
g. Communication systems.
h. Fire-detection and -alarm systems.
i. Conveying systems.
j. Electrical wiring systems.
k. Operating systems of special construction.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include, but are not limited to, the following:

a. Membranes and flashings.
b. Equipment supports.
c. Piping, ductwork, vessels, and equipment.
d. Noise- and vibration-control elements and systems.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.
2. Use materials whose installed performance is equal to or greater than the in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

3.2 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting and patching operations include, but are not limited to, the following; unless specifically noted otherwise:

a. Cutting openings in existing walls, ceilings or surfaces for new work.
b. Clearance required to installation of new work.
c. Access required to install new thermal and moisture protection products.
d. Installation of blocking or other miscellaneous support materials in existing construction.
e. Coordination of work to review existing conditions, uncover work for access or inspection, to obtain samples for testing, or to allow alterations for other similar purposes.
f. Installation of conduits, pipes, ducts, and wiring in existing surfaces and shafts.
g. Restoration and reinstallation of non-complying work shall be installed per specification section that governs the work in accordance with cutting and patching requirements.
h. Work not installed in accordance with the project schedule shall be installed per requirements of individual specification sections and in accordance with cutting and patching requirements.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Division 01 Section "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
5. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend from one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat

over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.
6. Restore work with new products in accordance with requirements of Contract Documents.
7. Fit work tightly to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
8. At penetrations of fire-rated wall, ceiling or floor construction, completely seal voids with fire-resistant materials as required to achieve fire-rating indicated.
9. Where fire protection materials are damaged or removed, reapply fire protection materials to achieve a rating equivalent to existing construction or as noted.
10. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

END OF SECTION 01 73 29

SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.

B. Related Requirements:

1. Division 01 Section "Cutting and Patching" for cutting and patching requirements.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Review specification requirements.
2. Inspect and discuss condition of construction to be selectively demolished.
3. Review structural load limitations of existing structure.
4. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

5. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
6. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property for environmental protection, for dust control, and for noise control. Indicate proposed locations and construction of barriers.

C. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

D. Predemolition Photographs or Video: Submit before Work begins.

E. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:

1. Roofing Membrane.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.

1. Comply with requirements specified in Division 01 Section "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.

3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Contractor shall arrange to shut off indicated services/systems as required by the performance of the work.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PROTECTION

A. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.

5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Division 01 Section "Temporary Facilities and Controls."

B. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least 4 hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials legally and promptly.
11. Do not perform demolition in a manner that leaves demolished material in soils around building.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Division 01 Section "Temporary Facilities and Controls."

C. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

B. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

C. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Division 07 Section "Thermoplastic Polyolefin (TPO) Roofing" for new roofing requirements.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.7 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General 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, for the following:

1. Footings.
2. Slabs-on-grade.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealants used in conjunction with interior and exterior concrete work, and water repellent applications to exterior concrete.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

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

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. Samples: For vapor barrier.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.
4. Curing compounds.
5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Vapor barriers.
9. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

E. Field quality-control reports from testing agency,

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

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.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.

D. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

E. 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.

F. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

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

1. ACI 301, "Specifications for Structural Concrete,"
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
3. ACI 318 "Building Code Requirements for Reinforced Concrete."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Steel Bar Mats: ASTM A 184/A 184M, fabricated from deformed bars, assembled with clips.

C. Deformed-Steel Wire: ASTM A 496/A 496M.

D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

E. Epoxy Coated Reinforcing: ASTM A 615/A 615M, grade 60 deformed, coated with less than 2% damaged coating in each 12 inch bar length.

2.2 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. 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:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For slabs-on-grade, use supports with sand plates or horizontal runners where wetted base material will not support chair legs.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I or Type III.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

1. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter; crushed stone, processed from natural rock or stone, with maximum size between ¾" and 1-1/2", and with a minimum size Number 4.
2. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps, or other deleterious substances. Hard and durable particles varying from fine to particles passing a 3/8" screen, of which at least 12% shall pass a 50-mesh screen. Dune sand, bank-run sand and manufactured sand shall not be used.

3. Local aggregates not complying with ASTM C 33, but which have shown by special test or actual service to produce concrete of adequate strength and durability, may be used when acceptable to the Architect.
4. For exposed interior surfaces, do not use fine or coarse aggregates that contain substrates that cause spalling.

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

D. Volatile Organic Compounds (VOC's): No product used shall contain a level of VOC's exceeding the limits established by the EPA in 40 CFR Part 59.

2.4 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Use of calcium chloride is not permitted.

B. Air-Entraining Admixture: ASTM C 260.

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

a. Euclid Chemical Co.; "Air-Mix" or "Perma-Air."
b. Grace W.R. & Co.; "Darex AEA" or "Daravair."
c. BASF Construction Chemicals, Inc.; "MasterAir-AE90."
d. Sika Corp.; "Sika AER."

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will 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.

D. 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.

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

a. Euclid Chemical Company (The), an RPM company; "EUCON BCN".
b. Grace Construction Products, W. R. Grace & Co.; "DCI."
c. Sika Corporation; "Sika CNI."

2.5 VAPOR BARRIERS

A. Sheet Vapor Barrier: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

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

a. Meadows, W. R., Inc.; "Perminator 15 mil."
b. Raven Industries Inc.; "Vapor Block 15."
c. Stego Industries, LLC; "Stego Wrap 15 mil Class A."

2.6 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces for use on interior floor surfaces indicated as exposed concrete.

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

a. Curecrete Distribution Inc.; "Ashford Formula."
b. L&M Construction Chemicals, Inc.; "Seal Hard."
c. Meadows, W. R., Inc.; "LIQUI-HARD."

2.7 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Dissipating, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating certified by manufacturer to be compatible with clear penetrating water repellent for use at exterior concrete and all areas receiving a clear penetrating water repellent.

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

a. L&M Construction Chemicals, Inc.; "L&M Cure R."
b. Meadows, W. R., Inc.; "1100-CLEAR."
c. Anti-Hydro International, Inc.; "AH Curing Compound #2 DR WB."

E. Clear, Waterborne, Non-Dissipating, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating**,** certified by curing compound manufacturer to not interfere with bonding of floor covering for use on concrete to receive tile, carpet and other specified flooring. Do not use on concrete receiving a specialty coating, cementitious topping or clear penetrating water repellent.

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

a. L&M Construction Chemicals, Inc.; "Dress & Seal WB 30."
b. Meadows, W. R., Inc.; "Vocomp-30."
c. Anti-Hydro International, Inc.; "AH Clear Cure WB."

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

1. Products: Subject to compliance with requirements, provide the following product or an equal product of another manufacturer that meets or exceeds the properties of the following product:

a. W.R. Meadows, Inc.; "Fiber Expansion Joint."

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, 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, non-load bearing and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

E. Grout: Pre-mixed, non-shrink grout complying with ASTM C 1107, Grade C:

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

a. Euclid; "N-S Grout."
b. L&M Construction Chemicals; "Duragrout."
c. Meadows, W.R. Inc.; "588-10K."

2.9 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.
2. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
3. Adjustment to Concrete Mixtures: Mixture design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the Owner and as accepted by the Architect. Laboratory test data for revised mix design and strength results shall be submitted to and accepted by the Architect before using in the work.

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

C. Admixtures: Use admixtures according to manufacturer's written instructions for climate conditions at the time of placement. Adjust quantities and type of admixtures as required to maintain quality control. Reduction in cement content is not permitted. Do not use admixtures not specified or approved.

1. Use water-reducing or high-range water-reducing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
5. Use air-entraining admixture in exterior exposed concrete. Add air-entraining admixture at manufacturer's prescribed rate and in accordance with ACI 318.

6. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and type of admixtures as required to maintain quality control. Reduction in cement content is not permitted. Do not use admixtures not specified or approved.

2.10 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3500 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 3 inches or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture.
4. Air Content: 5.5 percent, plus or minus 1 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1 percent at point of delivery for 1-inch3/4-inch nominal maximum aggregate size.

B. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3500 psi at 28 days.
2. Minimum Cementitious Materials Content: 520 lb/cu. yd.

    a. For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements.

3. Slump Limit: 3 inches.
4. Air Content: 3 percent maximum at trowel finished floors.
5. Air Content: 5.5 percent, plus or minus 1 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
6. Air Content: 6 percent, plus or minus 1 percent at point of delivery for 1-inch 3/4-inch nominal maximum aggregate size.

C. Materials Not Permitted: The following materials, or any combination of materials are not permitted to be incorporated in concrete mixtures:

1. Fly Ash.
2. Pozzolan.
3. Ground Granulated Blast Furnace Slag.
4. Silica Fume.

2.11 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all labor, materials, and equipment to construct and complete all cast-in-place concrete work, according to all drawings and details, together with any other work specified herein.

1. Contractor shall verify all measurements, lines, connections, methods and materials, and adjust with the Architect all discrepancies before proceeding with the work.
2. Include all appliances, scaffoldings, runways, shorings, forms, reinforcing steel, welded wire fabric, all reinforcing accessories, vapor barrier under slabs on ground, expansion joints, control joints, water stops, and other specialties.
3. All concrete shall be reinforced. Where reinforcement is not called for on the plans or schedules, minimum reinforcement shall be provided in accordance with ACI 318. Minimum temperatures for reinforcement shall be provided in all slabs in accordance with ACI 318.

3.2 FORMWORK

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:

1. Class A, 1/8 inch for exposed smooth-formed finished surfaces.
2. Class C, 1/2 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar and to comply with ACI 347, to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level, and plumb work in finished structures.

E. Fabricate 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. Install keyways, reglets, recesses, and the like, for easy removal.
2. 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. 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.

1. Do now allow excess form-coating materials to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply according to manufacturer's instructions.
2. Coat steel forms with a non-staining, manufactured form-release agent to protect against rusting. Rust-stained steel formwork is not acceptable.

3.3 EMBEDDED ITEMS

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.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install dovetail anchor slots in concrete structures as indicated.
3. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screed strips by the use of strike-off templates or accepted compacting type screeds.

3.4 VAPOR BARRIERS

A. Sheet Vapor Barriers: Place, protect, and repair sheet vapor barrier according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal all joints and penetrations with manufacturer's recommended tape.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

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

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Do not use reinforcement having any of the following defects:

1. Bar lengths, depth, or bends exceeding the specified fabricating tolerances.
2. Bends or kinks not indicated on the drawings or required for this work.
3. Bars with cross-section reduced due to excessive rust or other causes.

D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Minimum concrete protection for reinforcement:

a. Footings, 3".
b. Columns and pedestals, 2".
c. Walls, 2".
d. Interior slabs, 2".
e. Exterior slabs 2".

2. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

E. Reinforce all concrete in accordance with indicated schedules, notes and details indicated on the Drawings.

1. Where reinforcement is not on the Drawings, walls shall be reinforced as follows:

a. Up to 8" walls: #4 at 10" E.W. in center.
b. 8" up to 12" walls: #4 at 8" E.W. in center.
c. 12" walls and over: #4 at 12" E.W., E.F.
d. Provide #4 at 8" spacing dowels from main walls to secondary walls. Provide #4 at 12" spacing corner bars – all outside corners of walls. Provide two #4 at 5'-0" each corner of openings in concrete floors and walls.
e. Replace area of steel interrupted by openings in concrete walls with ½ of the area on each side of the opening. Reinforcing to extend full length of span or height in the short directions and clear span plus 6' in the long direction of the walls. Provide a minimum of two #6 bars bottom, two #5 bars top, #4 ties at 12" and #4 at 12 H.E.F. over openings in concrete walls.

F. Lap all horizontal reinforcing steel 48 bar diameters.

G. Perform all cutting of reinforcing steel where the reinforcing steel interferes with Plumbing, Electrical, and other trades, and where reinforcing steel cannot be moved. Reinforcing steel that is cut shall be replaced as directed by the Architect at the Contractor's expense.

H. Conduits or pipes shall be spaced not closer than three (3) diameters on center, and shall be so placed as to avoid changing the locations of the reinforcement from that shown on the Drawings.

I. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

J. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.6 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.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

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. 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 will 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.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
4. Remove plastic caps for application of sealants as required.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 CONCRETE PLACEMENT

A. General: Comply with ACI 304, "Guide for Measuring, Mixing, Transporting, and Placing Concrete", and as specified.

B. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed. Thoroughly wet wood forms immediately before placing concrete where form coatings are not used.

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

D. Coordinate the installation of joint materials and vapor barriers with placement of forms and reinforcing steel.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be 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 to not 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.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
4. Pour foundation walls in lengths not exceeding 75'. Provide a gap of at least 2'-0" between succeeding pours. Gaps shall not be filled less than 72 hours after the adjacent sections are poured.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or 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.

G. 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 for three successive days, maintain delivered concrete mixture temperature within the 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.

H. 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.
3. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
4. Do not use retarding admixtures unless otherwise accepted in mix designs submitted to the Architect for acceptability.

3.8 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, re-straightening, 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 in one direction.

1. Apply scratch finish to surfaces indicated to receive concrete floor toppings and to receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Re-straighten, cut down high spots, and fill low spots. Repeat float passes and re-straightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by power-driven trowel. Continue troweling passes and re-straighten 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 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.

3.9 MISCELLANEOUS CONCRETE ITEMS

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. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases to height 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: 3500 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.

C. Reinforced Masonry: Provide concrete grout for reinforced masonry where indicated on Drawings and as scheduled.

3.10 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 ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed 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. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, 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.

    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

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.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

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.

3.11 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatments on interior floor surfaces indicated as finished exposed concrete according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than three days' old but no earlier than recommended by the manufacturer.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.12 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

D. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

A. Testing and Inspecting: Contractor shall engage a qualified testing and inspecting agency to witness concrete placement and to perform tests and inspections and to submit reports.

B. Inspections:

1. Observe concrete placement and confirm no water is added on-site.
2. Steel reinforcement placement.

3. Steel reinforcement welding.
4. Headed bolts and studs.
5. Verification of use of required design mixture.
6. Concrete placement, including conveying and depositing.
7. Curing procedures and maintenance of curing temperature.
8. 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 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.

    a. When frequency of testing will provide 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.

2. 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.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M.

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

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

3.15 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 30 00

SECTION 04 20 00 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Miscellaneous masonry accessories.

B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for installing dovetail slots for masonry anchors.
2. Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.

C. Products installed, but not furnished, under this Section include the following:

1. Steel lintels and shelf angles for unit masonry, furnished under Division 05 Section "Metal Fabrications."
2. Hollow-metal frames in unit masonry openings, furnished under Division 08 Section "Hollow Metal Doors and Frames."

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement. "Show elevations of reinforced walls.

3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

1.5 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Qualification Data: For firms indicated in "Quality Assurance Article."

C. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Independent testing agency acceptable to the authorities having jurisdiction, qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review specification requirements, including Special Unit Masonry Project Tolerances.
2. Review installation procedures.
3. Inspect project conditions.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.

1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.
2. Do not apply mortar to substrates with temperatures of 100 deg F and above.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Concrete Masonry Units (CMUs): ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi.
2. Density Classification: Lightweight
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Exposed Faces: Provide uniform texture type, aggregate size and mix ratio adjusted to provide an extremely fine smooth face texture free of fissures, voids and other defects.
5. Products: Subject to compliance with requirements, provide concrete masonry units from one of the following manufacturers:

a. Anchor Block Company.

b. Carlisle Concrete Products
c. Eastern Industries, Inc.
d. Fizzano Brothers Concrete Products, Inc.
e. Keystone Block & Supply Co., Inc.
f. Standard Concrete Products Co., Inc.
g. Terre Hill Concrete Products.

B. Concrete Building Brick: ASTM C 55.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3750 psi.
2. Density Classification: Lightweight.
3. Size (Actual Dimensions): 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.

2.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I, except Type III may be used for cold-weather construction. Provide natural color or white cement.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

E. Aggregate for Grout: ASTM C 404.

F. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

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

a. ACM Chemistries; "RainBloc for Mortar."
b. BASF Aktiengesellschaft; "Rheopel Mortar Admixture."
c. Grace Construction Products, W. R. Grace & Co. - Conn.; "Dry-Block Mortar Admixture."

G. Water: Potable.

2.4 REINFORCEMENT

A. Basis of Design: Subject to compliance with requirements, Masonry Joint Reinforcement incorporated into the project shall be based on products manufactured as follows:

a. Single Wythe Wall: Hohmann & Barnard, Inc.; "#120 Truss Mesh."
b. Multi Wythe Wall: Hohmann & Barnard, Inc.; "#170 Lox-All Adjustable Eye Wire."

B. Acceptable Manufacturers: Subject to compliance with requirements, in lieu of the Basis of Design manufacturer, Contractor may provide products from other manufacturers that meet or exceed the published data of the specified Basis of Design product.

C. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior and Exterior Walls: Hot-dip galvanized, carbon steel.
2. Wire Size for Side Rods: 0.148-inch diameter.
3. Wire Size for Cross Rods: 0.148-inch diameter.
4. Wire Size for Veneer Ties: 0.148-inch diameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
6. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

D. Masonry Joint Reinforcement for Single-Wythe Masonry: Truss type with single pair of side rods.

2.5 TIES AND ANCHORS

A. Basis of Design: Subject to compliance with requirements, Ties and Anchors incorporated into the project shall be based on products as manufactured by as follows, in sizes as required by project conditions:

1. Masonry to Masonry Wall Ties: Hohmann & Barnard, Inc.; "MWT-Mesh Wall Tie."

B. Acceptable Manufacturers: Subject to compliance with requirements, in lieu of the Basis of Design manufacturer, Contractor may provide products from other manufacturers that meet or exceed the published data of the specified Basis of Design product.

C. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
2. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

E. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
2. Where wythes do not align or are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
3. Wire: Fabricate from 3/16-inch- diameter, hot-dip galvanized steel wire.

F. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- diameter, hot-dip galvanized steel wire.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch- diameter, hot-dip galvanized steel wire.

G. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 01.05-inch- thick, steel sheet, galvanized after fabrication.
2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch-diameter, hot-dip galvanized steel wire.

H. Partition Top Anchors: 0.105-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

I. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.6 MISCELLANEOUS ANCHORS

A. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

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

1) Advanced Building Products Inc.; "Mortar Maze Weep Vent."
2) Blok-Lok Limited; "Cell-Vent."
3) Dayton Superior Corporation, "Dur-O-Wal Division; Cell Vents."
4) Heckmann Building Products Inc.; "No. 85 Cell Vent."
5) Hohmann & Barnard, Inc.; "Quadro-Vent."
6) Wire-Bond; "Cell Vent."

E. Column Separation Material: Continuous cellulose column wrap material as follows:

1. Williams Products, Inc.; 'Column Boxboard."

2.8 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use portland cement-lime mortar unless otherwise indicated.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.
3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.
4. For interior non-load-bearing partitions, Type S.

C. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Do not install unit masonry that is damaged, cracked or has chipped corners. Remove and replace any unit masonry that contain these issues.

F. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

G. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

1. Tooth new masonry units into existing masonry units.

H. Do not wet CMUs.

3.3 SPECIAL UNIT MASONRY PROJECT TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/4 inch or minus 1/8 inch.
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/4 inch.
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/8 inch in a story height or 1/4 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 5 feet or 1/4 inch maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 3/16 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum.
5. For lines and surfaces do not vary from straight by more than 3/16 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 3/16 inch in 10 feet, or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.
6. For exposed bed joints interrupted by control or expansion joints, bed joint line and level shall not vary by more than 1/8" inch.

D. Masonry installations that do not conform to the Special Unit Masonry Tolerances indicated above shall be removed and reinstalled.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond, unless noted otherwise on Drawings; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
5. In accordance with the Special Unit Masonry Project Tolerances listed in this Section.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

1. At cavity walls, bevel beds away from cavity, to minimize mortar protrusions into cavity. As work progresses, trowel mortar fins protruding into cavity flat against the cavity face of the brick.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. Masonry joints above ceilings shall be struck flush starting two masonry courses above ceiling.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of both wythes align, use truss-type reinforcement extending across both wythes.
b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

3.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.9 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Install preformed control-joint gaskets designed to fit standard sash block.

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

D. Control Joint Spacings: If location of control (vertical movement) joints is not shown, place vertical joints at not more than 25'-0" center-to-center spacing; locate joints at columns when spacing exceeds 20'-0". Verify location of all control joints with Architect.

3.10 LINTELS

A. Install steel lintels where indicated and above all openings in masonry walls including above all metal frames (unless scheduled to be framed with metal studs and gypsum board/veneer plaster); above all wall openings, passages, windows, metal louvers, grilles, elevator doors, roll up shutters, etc.; above all HVAC ducts passing through masonry walls, return air openings, etc. (Refer to HVAC drawings for locations); above all built-in items, (cabinet heaters, convectors, louvers, fans, access panels, fire extinguisher cabinets, plumbing valve cabinets, hose cabinets, recessed electric panels, etc.); and in addition to locations noted or shown on the Drawings.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels when approved in advance by the Architect.

C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.11 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height and as follows:

a. Do not exceed the following pour heights for fine grout:

1) For minimum widths of grout spaces of ¾ inch or for minimum grout space of hollow unit cells of 1-1/2 by 2 inches, pour height of 12 inches.
2) For minimum widths of grout spaces of 2 inches or for minimum grout space of hollow unit cells of 2 by 3 inches, pour height of 60 inches.
3) For minimum widths of grout spaces of 2-1/2 inches or for minimum grout space of hollow unit cells of 2-1/2 by 3 inches, pour height of 12 feet.
4) For minimum widths of grout spaces of 3 inches or for minimum grout space of hollow unit cells of 3 by 3 inches, pour height of 24 feet.

b. Do not exceed the following pour heights for coarse grout:

1) For minimum widths of grout spaces of 1-1/2 inches or for minimum grout space of hollow unit cells of 1-1/2 by 3 inches, pour height of 12 inches.
2) For minimum widths of grout spaces of 2 inches or for minimum grout space of hollow unit cells of 2-1/2 by 3 inches, pour height of 60 inches.
3) For minimum widths of grout spaces of 2-1/2 inches or for minimum grout space of hollow unit cells of 3 by 3 inches, pour height of 12 feet.
4) For minimum widths of grout spaces of 3 inches or for minimum grout space of hollow unit cells of 3 by 4 inches, pour height of 24 feet.

c. Provide cleanout holes at least 3 inches in least dimension for grout pours over 60 inches in height.

1) Provide cleanout holes at each vertical reinforcing bar.
2) At solid grouted masonry, provide cleanout holes at not more than 32 inches o.c.

3.12 REPAIRING, POINTING, CLEANING, AND PROTECTION

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units or installations out of compliance with the Special Unit Masonry Project Tolerances indicated in this Section. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

1. Contractor shall identify and replace units noted above as part of their quality control program. Architect reserves the right to back charge Contractor for their time to identify masonry units if Contractor fails to identify and replace non-compliant installations.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

1. Do not dispose of masonry waste as fill within 18 inches of finished grade.

B. Masonry Waste Recycling: Return broken CMU's not used as fill to manufacturer for recycling.

C. Excess Masonry Waste: Remove excess clean masonry waste and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 04 20 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section:

1. Loose steel lintels for all masonry wall penetrations.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
4. Rough hardware.

C. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
3. Division 09 Section "Painting & Finishing."

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Design, engineer, fabricate, and install the following metal fabrications to withstand the required structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each metal fabrication.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Paint products.
2. Grout.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.5 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units without causing delay in the work.

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

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages and steel weld plates and angles for casting into concrete. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Steel Tubing: ASTM A 500, cold-formed steel tubing.

F. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: 1-5/8 by 1-5/8 inches.
2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33, with G90 coating; 0.079-inchnominal thickness.
3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, Grade 33; 0.0677-inch minimum thickness; hot-dip galvanized after fabrication.

H. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

D. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

E. Bronze Plate, Sheet, Strip, and Bars: ASTM B 36/B 36M, Alloy UNS No. C28000 (muntz metal, 60 percent copper).

F. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).

G. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).

H. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.

I. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless-steel fasteners for fastening aluminum.
2. Provide stainless-steel fasteners for fastening stainless steel.
3. Provide stainless-steel fasteners for fastening nickel silver.
4. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Eyebolts: ASTM A 489.

G. Machine Screws: ASME B18.6.3.

H. Lag Screws: ASME B18.2.1.

I. Wood Screws: Flat head, ASME B18.6.1.

J. Plain Washers: Round, ASME B18.22.1.

K. Lock Washers: Helical, spring type, ASME B18.21.1.

L. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

M. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

N. Post-Installed Anchors: Torque-controlled expansion anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

O. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi.

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

J. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.
3. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 1-1/4 inches wide by 1/4 inch thick by 8 inches long at 24 inches o.c., unless otherwise indicated.

C. Galvanize miscellaneous framing and supports at exterior locations and where indicated.

2.8 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

2.9 LOOSE STEEL LINTELS

A. Provide steel lintels above all openings in masonry walls and brick veneer including above all metal frames (unless scheduled to be framed with metal studs and gypsum board/veneer plaster); above all wall openings, passages, windows, metal louvers, grilles, etc.; above all HVAC ducts passing through masonry walls, return air openings, etc. (Refer to HVAC drawings for locations); above all built-in items, (cabinet heaters, convectors, louvers, fans, access panels, fire extinguisher cabinets, plumbing valve cabinets, hose cabinets, recessed electric panels, etc.) in addition to those noted/shown on the plans, wall sections and details.

B. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

C. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

D. Galvanize loose steel lintels located in exterior walls.

2.10 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.11 ROUGH HARDWARE

A. Furnish bent, or otherwise custom fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 06 Sections.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts that bear on wood structural connections, and furnish steel washers elsewhere.

2.12 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.13 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Division 09 Section "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Items: SSPC-SP 3, "Power Tool Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 PREPARATION

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.

B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.2 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.4 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

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

END OF SECTION 05 50 00

SECTION 07 01 50 - PREPARATION FOR REROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cutting and patching of new and existing openings in roof.

1.3 DEFINITIONS

A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.

B. Full Roof Tear-Off: Removal of existing roofing system from deck.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include plans, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1. Include certificate that Installer is approved by warrantor of existing roofing system.

B. Fastener pull-out test report.

C. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations. Submit before Work begins.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning roofing removal. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.7 PREINSTALLATION MEETINGS

A. Reroofing Conference: Conduct conference at Project site.

1. Meet with Owner; Architect; roofing system manufacturer's representative; roofing Installer, including project manager, superintendent, and foreman; and installers whose work interfaces with or affects reroofing, including installers of roof deck, roof accessories, and roof-mounted equipment.
2. Review methods and procedures related to roofing system tear-off and replacement, including, but not limited to, the following:

a. Reroofing preparation, including roofing system manufacturer's written instructions.
b. Temporary protection requirements for existing roofing system components that are to remain.
c. Existing roof drains and roof drainage during each stage of reroofing, and roof-drain plugging and plug removal.
d. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to avoid delays.
e. Existing roof deck conditions requiring notification of Architect.
f. Existing roof deck removal procedures and Owner notifications.
g. Condition and acceptance of existing roof deck and base flashing substrate for reuse.
h. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that affect reroofing.
i. Existing HVAC systems.
j. Existing fire-suppression, -protection, and -alarm and -detection systems.
k. Governing regulations and requirements for insurance and certificates if applicable.
l. Existing conditions that may require notification of Architect before proceeding.

1.8 FIELD CONDITIONS

A. Existing Roofing System: Ballasted EPDM roofing.

B. Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so Owner's operations are not disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.

1. Coordinate work activities daily with Owner so Owner can place protective dust and water-leakage covers over sensitive equipment and furnishings, shut down HVAC and fire-alarm or -detection equipment if needed, and evacuate occupants from below work area.

C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.

D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

E. Conditions existing at time of inspection for bidding are maintained by Owner as far as practical.

F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

1. Remove only as much roofing in one day as can be made watertight in the same day.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during reroofing, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.

1. Notify warrantor of existing roofing system on completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 TEMPORARY PROTECTION MATERIALS

A. Expanded Polystyrene (EPS) Insulation: ASTM C 578.

B. Plywood: DOC PS1, Grade CD Exposure 1.

C. OSB: DOC PS2, Exposure 1.

PART 3 - EXECUTION

3.1 PREPARATION

A. Shut off rooftop utilities and service piping before beginning the Work.

B. Test existing roof drains to verify that they are not blocked or restricted. Immediately notify Architect of any blockages or restrictions.

C. Protect existing roofing system that is not to be reroofed.

1. Loosely lay 1-inch- (25-mm-) minimum thick, expanded polystyrene (EPS) insulation over existing roofing in areas indicated. Loosely lay 15/32-inch (12-mm) plywood or OSB panels over EPS. Extend EPS past edges of plywood or OSB panels a minimum of 1 inch (25 mm).
2. Limit traffic and material storage to areas of existing roofing that have been protected.
3. Maintain temporary protection and leave in place until replacement roofing has been completed. Remove temporary protection on completion of reroofing.

D. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

E. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

3.2 ROOF TEAR-OFF

A. Remove aggregate ballast from roofing and store for reinstallation.

B. Full Roof Tear-Off: Remove existing roofing and other roofing system components down to the deck.

1. Remove roof insulation.

3.3 DECK PREPARATION

A. Inspect deck after tear-off of roofing system.

B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify Architect. Do not proceed with installation until directed by Architect.

C. Provide additional deck securement as indicated on Drawings.

D. Provide additional steel deck as indicated on Drawings.

3.4 INFILL MATERIALS INSTALLATION

A. Immediately after roof tear-off, and inspection and repair, if needed, of deck, fill in tear-off areas to match existing roofing system construction.

B. Install new roofing patch over roof infill area. If new roofing is installed the same day tear-off is made, roofing patch is not required.

3.5 DISPOSAL

A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.

1. Storage or sale of demolished items or materials on-site is not permitted.

B. Transport and legally dispose of demolished materials off Owner's property.

END OF SECTION 07 01 50

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.
2. Penetrations in smoke barriers.

B. Related Sections:

1. Division 07 Section "Joint Firestopping" for joints in or between fire-resistance-rated construction.

1.3 ACTION SUBMITTALS

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

B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site in conjunction with fire-resistive joint systems and insulation preinstallation conference:

1. Review specification requirements.
2. Review installation procedures.
3. Inspect project conditions.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

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

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. Nelson Firestop Products, a brand of Emerson Industrial Automation.
d. Tremco, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL

A. Contractor shall schedule the Authority Having Jurisdiction to perform inspections of installed penetration fireproofing.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after installations comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 07 84 13

SECTION 07 84 43 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated constructions.
2. Joints in smoke barriers.

B. Related Requirements:

1. Division 07 Section "Penetration Firestopping" for penetrations in fire-resistance-rated walls and smoke barriers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review specification requirements.
2. Review installation procedures.
3. Inspect project conditions.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."

2.2 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.

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

    a. 3M Fire Protection Products.
    b. Hilti, Inc.
    c. Nelson Firestop; a brand of Emerson Industrial Automation.
    d. Roxul Inc.
    e. Thermafiber, Inc.; an Owens Corning company.
    f. Tremco, Inc.

2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg.

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

    a. 3M Fire Protection Products.
    b. Hilti, Inc.
    c. Nelson Firestop; a brand of Emerson Industrial Automation.
    d. Roxul Inc.
    e. Thermafiber, Inc.; an Owens Corning company.
    f. Tremco, Inc.

2. L-Rating: Not exceeding 5.0 cfm/ft. of joint at both ambient and elevated temperatures.

D. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

E. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

2.3 SAFING INSULATION

A. Mineral Wood Loose Fill Insulation: ASTM E 136 with maximum flame spread and smoke developed indexes of 0; ASTM E 84 and density of 4.0 pcf.

1. Basis of Design: Subject to compliance with requirements, Safing Insulation incorporated into the project shall be based on products as manufactured as follows:

    a. Thermafiber by Owens-Corning; "Safing Insulation."

2. Acceptable Manufacturers: Subject to compliance with requirements, in lieu of the Basis of Design manufacturer, Contractor may provide products from manufacturers that meet or exceed the published data of the specified Basis of Design product.

B. Safing Clips: Z-Shaped galvanized steel clips formed from 1 inch wide strips of 20 gauge galvanized steel; 3 inches high with 2 inch and 3 inch upper and lower horizontal legs. See specific UL or OPL/Intertek design to verify if safing clips are required.

C. Backer / Reinforcement Member: Thermafiber Impasse T-Bar or other light gauge steel channel or angle approved by the primary manufacturer. Place horizontally at the safe-off line to support the curtain wall

insulation to prevent bowing of curtain wall insulation caused by compression fitting of the Safing insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Contractor shall engage the Authority Having Jurisdiction to perform inspections.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 07 84 43

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Nonstaining silicone joint sealants.
2. Urethane joint sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized installer who is trained and approved by manufacturer.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review specifications.
2. Review installation procedures.
3. Inspect project conditions.

1.7 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

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

a. Dow Consumer Solutions; "DOWSIL 790".
b. Sika Corporation; "Sikasil WS-290 FPS".
c. Pecora Corporation; "890 NST".

d. Tremco Incorporated; "Spectrem 1".

2. Joint Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.
3. Joint Locations:

a. Control joints in unit masonry.
b. Joints between metal panels and flashings.
c. Joints between different materials listed above.

2.3 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

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

a. Sika Corporation U.S.; "Sikaflex 15LM".

2. Joint Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
3. Joint Locations:

a. Control joints on exposed interior surfaces of exterior walls.
b. Perimeter joints between interior wall surfaces and frames of windows, doors and other openings.
c. Other interior joints.

B. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 25, Uses T and NT.

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

a. BASF Corporation Construction Systems "MasterSeal NP 2".
b. Bostik, Inc; "Chem-Calk 505".
c. Sika Corporation; "Sikaflex 2c NS EZ Mix".
d. Sherwin Williams; "Loxon NS2".

2. Joint Sealant Application: Interior joints in horizontal traffic surfaces.
3. Joint Locations:

a. Isolation joints in cast-in-place concrete slabs.
b. Other interior floor joints except noted otherwise.

2.4 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) and as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.5 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Masonry.

3. Remove laitance and form-release agents from concrete.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hollow-metal doors, frames and accessories.

B. Related Requirements:

1. Division 04 Section "Unit Masonry" for anchoring and grouting hollow metal frames set in masonry construction.
2. Division 08 Section "Door Hardware" for door hardware for hollow-metal doors.
3. Division 09 Section "Painting and Finishing" for finishing.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.

C. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review specification requirements.
2. Review installation procedures.
3. Inspect project conditions.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Ceco Door Products; an Assa Abloy Group company.
2. Curries Company; an Assa Abloy Group company.
3. Pioneer Industries, Inc.
4. Republic Doors and Frames.
5. Steelcraft; an Ingersoll-Rand company.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Doors and Frames: SDI A250.8, Level 2.

1. Physical Performance: Level B according to SDI A250.4.
2. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches.
c. Face: Uncoated**,** cold-rolled steel sheet, minimum thickness of 0.042 inch.
d. Edge Construction: Model 2, Seamless.
e. Core: Polystyrene.

3. Frames:

a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
b. Construction: Full profile welded.

4. Exposed Finish: Prime.

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames: SDI A250.8, Level 3.

1. Physical Performance: Level A according to SDI A250.4.
2. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches
c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
d. Edge Construction: Model 2, Seamless.
e. Core: Steel stiffened.

3. Frames:

   a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 coating.
   b. Construction: Full profile welded.

4. Exposed Finish: Prime.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
3. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Glazing: Comply with requirements in Division 08 Section "Glazing."

J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
3. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches.
4. Top Edge Closures: Close top edges of doors with inverted closures, except provide flush closures at exterior doors of same material as face sheets.
5. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
6. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:

        1) Two anchors per jamb up to 60 inches high.
        2) Three anchors per jamb from 60 to 90 inches high.
        3) Four anchors per jamb from 90 to 120 inches high.

4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Compression Type: Not less than two anchors in each frame.
c. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow-metal work.
5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.9 ACCESSORIES

A. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

a. At fire-rated openings, install frames according to NFPA 80.
b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
c. Install frames with removable stops located on secure side of opening.
d. Install door silencers in frames before grouting.
e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
5. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

    a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
    b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
    c. At Bottom of Door: 3/4 inch plus or minus 1/32 inch.
    d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow-metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 11 13

SECTION 08 71 00 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes:

1. Door hardware for swinging doors.
2. Door hardware for other doors to the extent indicated.
3. Cylinders for door hardware specified in other sections.
4. Key control system.

B. Related Sections:

1. Division 03 Section "Cast-in-Place Concrete" for installing recessed closers in concrete.
2. Division 08 Section "Hollow Metal Doors and Frames".

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

1. Provide complete manufacturer's catalog cuts for each item scheduled.

B. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate final door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents, in vertical format (horizontal format will not be reviewed).
3. Content: Include the following information:

a. Identification number, location, hand, fire rating, size, and material of each door and frame.
b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
c. Complete designations, including name and manufacturer, type, style, function, size, swing, quantity, function, and finish of each door hardware product.
d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.

e. Fastenings and other pertinent information.
f. Explanation of abbreviations, symbols, and codes contained in schedule.
g. Mounting locations for door hardware.
h. List of related door devices specified in other Sections for each door and frame.

C. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Architectural Hardware Consultant.

B. Product Certificates: For electrified door hardware, from the manufacturer.

1. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

A. Manufacturer's data for each piece of hardware.

B. Maintenance Data: For each type of door hardware to include in maintenance manuals.

C. Installation instructions for each piece of hardware for each door.

D. Bitting Lists for all keys.

E. Complete set of wiring diagrams for each door with door number indicated.

F. Final, as-built copy of hardware and keying schedule.

G. Warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and an Architectural Hardware Consultant who is available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Source Limitations: Obtain each type of door hardware from a single manufacturer.

C. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

D. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meet requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.

E. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

F. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

G. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:

a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

H. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant and a representative of the Door Hardware Manufacturer. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
2. Preliminary key system schematic diagram.
3. Requirements for key control system.
4. Requirements for access control.
5. Address for delivery of keys.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.8 COORDINATION

A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with the Owner.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion, unless otherwise indicated.

a. Exit Devices: Five years from date of Substantial Completion.
b. Manual Closers: 10 years from date of Substantial Completion.
c. Locksets: 10 years from date of Substantial Completion.

1.10 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Follow-Up Services: The hardware installer shall confirm, in writing, the operation of all door hardware is within tolerances prior to the General Contractor requesting Substantial Completion. In addition to warranty service required for issues realized post-occupancy during the warranty period, the installer shall re-review the operation of all door hardware ten months after Substantial Completion and shall make all adjustments required.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. Provide door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section.

1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. Products are identified by using door hardware designations, as follows:

1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Schedule" Article.

C. Basis of Design: Hardware scheduled in Part 3 "Door Hardware Schedule" shall be considered the Basis of Design product. Acceptable manufacturers listed in this Part shall provide products that meet or exceed the published data of the Basis of Design product where their product is provided in lieu of the Basis of Design product.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

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

a. Hager Companies.
b. IVES Hardware; an Allegion company.
c. McKinney Products Company; an ASSA ABLOY Group company.
d. Stanley Commercial Hardware; a dormakaba company.

2.3 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors.

C. Lock Backset: 2-3/4 inches, unless otherwise indicated.

D. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

E. Mortise Locks: BHMA A156.13; Security Grade 1; stamped steel case with steel or brass parts; Series 1000.

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

    a. SARGENT Manufacturing Company; an ASSA ABLOY Group company.

2.4 AUXILIARY LOCKS

A. Mortise Auxiliary Locks: BHMA A156.5; Grade 1; with strike that suits frame.

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

    a. SARGENT Manufacturing Company; an ASSA ABLOY Group company.

2.5 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3.

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

    a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
    b. Precision; a dormakaba company.
    c. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
    d. Stanley Commercial; a dormakaba company
    e. Von Duprin; an Allegion company.

2.6 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver.

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

    a. SARGENT Manufacturing Company; an ASSA ABLOY Group company; Signature Series, removable core master key system. Coordinate with the Owner's existing masterkey system.

B. High-Security Lock Cylinders: BHMA A156.30; Grade 1; Type M, mechanical; permanent cores that are removable; face finished to match lockset.

1. Core Type: Interchangeable.

C. Construction Cores: Provide construction cores that are replaceable by permanent cores.

2.7 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

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

    a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company.
    b. DORMA Architectural Hardware; a dormakaba company.
    c. LCN Closers; an Allegion company.
    d. Norton Door Controls; an ASSA ABLOY Group company.
    e. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
    f. Stanley Commercial; a dormakaba company.

2.8 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

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

    a. Glynn-Johnson; an Allegion company.
    b. Rockwood; an ASSA ABLOY Group company.
    c. SARGENT Manufacturing Company; an ASSA ABLOY Group company.
    d. Rixon Specialty Door Controls; an ASSA ABLOY Group company.
    e. National Guard Products.

2.9 DOOR SILENCERS

A. Door Silencers: BHMA A 156.16; rubber door silencer.

1. Basis of Design: Subject to compliance with requirements, Door Silencers incorporated into the project shall be based on products as follows:

    a. Rockwood Manufacturing Company, an ASSA ABLOY Group company; "608".

2. Acceptable Manufacturers: Subject to compliance with requirements, in lieu of the Basis of Design manufacturer, Contractor may provide products from the following manufacturers that meet or exceed the published data of the specified Basis of Design product.

    a. IVES Hardware, an Allegion Company.
    b. Hager Company.

2.10 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; air leakage not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

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

    a. Hager Companies.
    b. McKinney Products Company; an ASSA ABLOY Group company.
    c. National Guard Products.
    d. Pemko Manufacturing Co.; an ASSA ABLOY Group company.

e. Reese Enterprises, Inc.

2.11 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

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

a. IVES Hardware; an Allegion company.
b. Rockwood; an ASSA ABLOY Group company.
c. Hager Company.
d. McKinney Products Company, an ASSA ABLOY Group company.

2.12 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

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

a. Hager Companies.
b. Rockwood; an ASSA ABLOY Group company.
c. Stanley Commercial Hardware; a dormakaba company.
d. Allegion.

2.13 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference.

1. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.
2. Existing System:

a. Master key or grand master key locks to Owner's Sargent Signature Series existing system that shall match Owner's existing keyway.

B. Keys: Brass.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: "DO NOT DUPLICATE."

2. Quantity: In addition to one extra key blank for each lock, provide the following:

a. Cylinder Change Keys: Four.
b. Master Keys: Six.
c. Grand Master Keys: Six.
d. Great-Grand Master Keys: Six.

e. Control Keys: Two

2.14 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware or is indicated as a required use of through bolts. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt. Where through bolts are utilized, provide finish-threaded caps to fully conceal nuts.

a. Steel through bolts required at the following locations (no exceptions):

1) Door closers at all locations.

2. Fire-Rated Applications:

a. Wood or Machine Screws: For the following:

1) Hinges mortised to doors or frames
2) Strike plates to frames.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."
5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
6. Self-drilling "Tek" type screws are not acceptable. Use only fasteners supplied by hardware manufacturer.
7. Where it is not possible to reinforce substrate adequately for screws, use through-bolts with sleeves or use sex bolts.

a. Do not use where head or nut would be exposed on face of door, unless specifically indicated or made necessary by other requirements.
b. Finish exposed heads and nuts the same as hardware on that side of the door.

8. Use expansion shield anchors in concrete and masonry.

2.15 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. Steel Doors and Frames: For surface applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

B. Wood Doors: Comply with DHI WDHS.5 "Recommended Hardware Reinforcement Locations for Mineral Core Wood Flush Doors."

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Use manufacturers supplied installation templates.
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as indicated in keying schedule.

E. Closers:

1. Install door closer mounting brackets, arms, plates, and miscellaneous equipment as necessary to mount all door closers inside room, or out of corridor at every instance where a door closer is specified. No door closers (nor parts, nor accessories of) shall be visible from corridor side unless Architect has authorized specific and formal approval for that mounting application, and has clear understanding closer is visible through lite, and has approved such.
2. Install top jamb mounted units where hardware schedule lists closer functions that are not available in regular arm mounting configurations.
3. Thru-bolt all closers to doors with sex bolts. Install aluminum spacers for all 5th and 6th bolts at arm connections to metal head frames, and notify frame suppliers to install reinforcing plates to receive all bolts including 5th and 6th bolts.
4. Where any portion of the back of the closer is visible through glazing, a finish closure panel shall be installed.

F. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants." Provide Tampin expansion bolts at all thresholds.

G. Stops: Provide wall stops for doors unless floor or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

H. Door Silencers: Furnish at all hollow metal and wood frames. Each door leaf shall be supplied with three (3) bumpers each side. Do not provide on doors with sound seals or on exterior doors.

I. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame. All exterior doors shall be installed with a complete set of gasketing (including thresholds, sweeps, seals, astragals, and drips) whether specifically scheduled or not. Where gasketing provided shows evidence of being insufficient, new gaskets shall be provided at no additional cost

J. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

K. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

L. Primed Hardware: Paint factory-primed hardware in accordance with Division 09 Section "Painting & Finishing."

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended.

Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
3. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

B. Prior to Occupancy Adjustment: Adjust door closers to overcome air pressure produced by HVAC systems. If HVAC pressure, whether negative or positive, negates proper operation or function of any closing or latching device, or inhibits manufacturer's intended performance (in any manner), supplier shall inform the GC in writing that type of hardware cannot operate nor function as manufacturer has designed and tested due to HVAC condition.

C. Post Occupancy Adjustment: Review operation of door hardware six to eight weeks after Substantial Completion in the presence of the Owner's Representative. Adjust hardware as required to ensure proper operation.

1. Contractor will be required to re-visit site to adjust hardware omitted from onsite review.

3.5 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

3.7 HARDWARE MANUFACTURER LEGEND

Symbol	Manufacturer
SA	Sargent
ST	Stanley
RO	Rockwood

3.8 DOOR HARDWARE SCHEDULE

Set: 1.0

Door: 2156		Rated 90 Minutes	HM DR X HM FR
ST	Hinges	FBB 168	US26D
SA	Exit Device	12 64 8913 ETL	US32D
SA	Removable Core	6300	US15
SA	OH Closer	351 P10	EN
RO	Wall Stop	406	US26D
RO	Kick Plate	K1050 8" 4BE	US32D
RO	Silencers	608	Grey

Set: 2.0

Door: 2156A			HM DR X HM FR
ST	Hinges	FBB 168	US26D
SA	Exit Device	12 64 8913 ETL	US32D
SA	Removable Core	6300	US15
SA	OH Closer	351 P10	EN
RO	Wall Stop	406	US26D
RO	Kick Plate	K1050 8" 4BE	US32D
RO	Silencers	608	Grey

END OF SECTION 08 71 00

SECTION 09 91 00 – PAINTING AND FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on substrates.

B. Related Requirements:

1. Requirements for preparing, priming, painting, and finishing are included throughout the specifications. All specification sections shall be reviewed for painting and finishing requirements.
2. Division 05 Section "Metal Fabrications" for shop priming of metal substrates with primers specified in this Section.

1.3 DEFINITIONS

A. Gloss Level 1 (Matte Flat Finish): Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2 (Velvet-Like Flat Finish): Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3 (Eggshell Finish): 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4 (Satin Finish): 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5 (Semi-Gloss Finish): 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6 (Gloss Finish): 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7 (High-Gloss Finish): More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product.

1. Submit manufacturer's standard "fan deck" of colors.
2. Architect will request Samples for Verification after receipt of manufacturer's "fan deck."

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.
5. Architect will furnish color schedule approximately 10 weeks after receipt of samples and other color-dependent submittals of other specification sections.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Paint: 10 percent, but not less than 5 gal. of each material and color applied.

1.6 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1. Review specification requirements.
2. Review installation procedures, including review of proper preparation of existing wall surfaces as indicated in the MPI Maintenance & Repainting Manual.
3. Inspect project conditions, including existing wall surfaces which require cleaning and spackling as part of the work.

1.7 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to those indicated for the Project that have resulted in a construction record of successful in-service performance.

B. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue with manufacturer's data.
2. Remove rags and waste from storage areas daily.
3. Protect product from freezing.

1.9 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in rain, snow, fog, mist, or when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

C. Where moisture is present, the general contractor shall provide the necessary ventilation to establish appropriate condition. Should the surface be too dry for the product application, the painting contractor shall provide the necessary methods to establish the appropriate conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. The Sherwin Williams Company (SW).
2. PPG PAINTS Architectural Coatings (PPG).

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.

C. Colors: As selected by Architect from manufacturer's full range.

1. Interior Work: A maximum of 2 different pigmented colors will be used, with variations for trim, wall surfaces, wainscots, and graphics.
2. Dark Tones: A maximum of 2 dark tones will be used as accent colors for the interior.

D. Multiple Colors: Each room or space may have walls of more than one color. The right is reserved to vary the color after the first coat.

E. Color Guarantee: Painting Contractor shall guarantee all in-place paint and stain colors to match colors selected. Obtain copies of standard color charts used, and be certain all in-place paint and stain colors closely match selected colors. Surfaces which fail to pass color inspection shall be repainted at no additional cost to Owner.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. General: All areas listed in the Room Finish Schedule as receiving paint (i.e. walls, ceilings, etc.) shall be inclusive of all non-factory finished surfaces. All costs of preparation, cleaning, protection, priming, finishing, cleaning, etc. shall be included for all surfaces (wall, trim, moldings, frames, etc.) and materials (metal, wood, CMU, plaster, gypsum board, etc.) unless specifically noted otherwise. All work shall be in accordance with these Specifications and instructions in the Contract Documents.

B. Comply with manufacturer's written instructions and recommendations in "MPI Manual" and "Maintenance & Repainting Manual" as applicable to substrates indicated.

C. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

D. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
2. Clean existing surfaces of residue and miscellaneous applied finishes to provide a properly prepared surface to receive new finish.

E. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

F. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

G. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer**.**

H. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

I. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

J. Aluminum Substrates: Remove loose surface oxidation.

K. Wood Substrates for Painting:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and according to recommendations in "MPI Manual."

1. Materials shall be applied with roller or brush, except that spraying will be permitted for items such as mechanical equipment, grilles, or similar items. Mask off adjoining areas not receiving a spray finish against overspray.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on existing surfaces painted previously or on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

a. Spot prime where required or provide alternative preparation product as recommended by manufacturer.

B. Apply stains and finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for finish and substrate indicated.
2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. If, in the opinion of the Architect, adequate block filler, primer, paint or coating coverage is not provided, Contractor shall apply additional coats to satisfy Architect, at no additional cost to the Owner.

D. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

E. Apply paints, stains and finishes to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

F. Paint exposed surfaces whether or not colors are designated in "schedules", except where natural finish of materials is specifically noted as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint same as adjacent similar materials or areas. If color or finish is not designated, Architect will select these from standard colors available for materials systems specified.

G. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint all new and existing mechanical and electrical work where exposed in occupied spaces including, but not limited to:

a. Equipment not prefinished.
b. Uninsulated metal piping, except chrome finished.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Electrical conduit, boxes, raceways and trays.
f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
g. Other items as directed by Architect.

2. Mechanical and electrical items to be painted shall be finished the color(s) of the adjacent surface unless noted otherwise. Any questions regarding the color(s) to be provided shall be submitted to the Architect for clarification.
3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

a. Color: SW 6991 "Black Magic".

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.

2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 PAINTING AND FINISHING SCHEDULE

A. Concrete and Masonry Substrates

1. Interior, Latex, Non-Traffic Surfaces: Gloss Level 3

a.	SW	Filler (masonry):	PrepRite Block Filler (B25W25)
		Primer (concrete):	Loxon Masonry Primer
		1st coat:	ProMar 200 Zero VOC
		2nd coat:	ProMar 200 Zero VOC
b.	PPG	Filler (masonry):	SPEEDHIDE Hi Fill Latex Block Filler 6-15X1 Series
		Primer (concrete):	SEAL GRIP Acrylic Universal Primer 17-921 Series
		1st coat:	SPEEDHIDE Zero 6-4310XI Series
		2nd coat:	SPEEDHIDE Zero 6-4310XI Series

B. Metal Substrates:

1. Interior, Ferrous Metals, Latex: Gloss Level 5

a.	SW	Primer*:	DTM Primer / Finish
		1st coat:	DTM Acrylic Finish
		2nd coat:	DTM Acrylic Finish
b.	PPG	Primer*:	Pitt Tech Plus DTM Industrial Primer 4020
		1st coat:	Pitt Tech Plus Industrial DTM 4216 Series
		2nd coat:	Pitt Tech Plus Industrial DTM 4216 Series

*Spot prime where metals are shop coated or primed

2. Interior, Ferrous Metals, Dryfall, Latex: Gloss Level 1

a.	SW	Primer*:	Pro-Cryl Universal Primer

		1st coat:	Waterborne Acrylic Dryfall
		2nd coat:	Waterborne Acrylic Dryfall
b.	PPG	Primer*:	Pitt Tech Plus DTM Industrial Primer 4020
		1st coat:	Pitt Tech Plus Industrial DTM 4216 Series
		2nd coat:	Pitt Tech Plus Industrial DTM 4216 Series

*Spot prime where metals are shop coated or primed

3. Non-Ferrous Metals, (Galvanized), Latex: Gloss Level 5

a.	SW	Primer:	DTM Primer / Finish
		1st coat:	ProIndustrial DTM Acrylic Finish
		2nd coat:	ProIndustrial DTM Acrylic Finish
b.	PPG	Primer:	SPEEDHIDE Galvanized Steel Primer 6-209 Series
		1st coat:	Pitt Tech Plus Industrial DTM 90-1210 Series
		2nd coat:	Pitt Tech Plus Industrial DTM 90-1210 Series

END OF SECTION 09 91 00

SECTION 220010 - BASIC REQUIREMENTS – PLUMBING CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for plumbing system installations. Administrative and procedural requirements are included in this Section and in various Division 1 Sections.

1.3 PERMITS AND FEES

A. Refer to Non-Technical Specifications, General Conditions for information relating to permits and fees.

1.4 PROJECT SCHEDULE

A. Refer applicable Non-technical specification sections for contract completion time and project construction schedule.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. Follow the procedures specified in the Division 01 sections. Also refer to individual sections of the Division 22 specifications for additional shop drawing and Submittal requirements.

B. It is the responsibility of the contractor to thoroughly review any and all shop drawings prior to submission to the Architect/Engineer. The contractor's review shall include verifying conformance to the project documents. The contractor will also be responsible for verifying the quantities of materials are adequate.

C. All shop drawings shall be submitted with a cover sheet indicating the name of the project, the Architects and Engineers name, the name of the vendor and the contractor. There must be sufficient space on the title sheet to allow the appropriate stamping by both the Architect and the Engineer. Shop drawings and submittals not conforming to the above may be returned without review.

D. All shop drawing submittals will include a listing of any and all exceptions to the requirements indicated in the specifications and on the drawings. Where there are no exceptions, the submittals shall indicate such. Submittals that do not have this listing will not be reviewed.

1.6 COORDINATION DRAWINGS

A. Coordination drawings are required. Refer to applicable Division 01 sections for the work required by this Contractor in preparing Coordination Drawings.

1.7 INSTALLATION ACCESSIBILITY

A. The installation of all equipment and appurtenances shall be done so that access and clearances meet the requirements of the equipment manufacturer and all applicable codes.

1.8 RECORD DOCUMENTS

A. Prepare record documents in accordance with applicable Division 01 sections. In addition to the requirements specified, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

4. Contract Modifications, actual equipment and materials installed.

5. Record Documents are to be prepared and/or revised to indicate the room names and numbers to be used by the owner after the projects is complete.

1.9 OPERATING AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with applicable Division 01 sections.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. When materials and products are stored on site, provide protection from weather and temperatures that may cause damage to the items.

1.11 EXTRA MATERIALS

A. Various specification sections may indicate extra materials that are to be provided with the respective equipment. Where indicated the contractor shall provide the required extra materials. When directed by the owners representative, the contractor shall install the extra filters in the respective equipment. If no additional installation is required, the contractor shall forward, to the owner, all extra materials. When forwarding materials obtain a receipt for any materials forwarded.

PART 2 - PRODUCTS

2.1 Not Applicable.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Obtain equipment shop drawings for the various items that require rough-in.

3.2 MECHANICAL INSTALLATIONS

A. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Coordinate requirements for chases slots, and openings in other building components during the progress of construction, to allow for mechanical installations.
4. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
5. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
6. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
9. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
10. Install systems, materials, and equipment giving right-of-way priority to the systems required to be installed at a specified slope.
11. Seal all places where piping pass through walls and floors.

3.3 CUTTING AND PATCHING

A. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.
2. Removal and replacement of defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Remove samples of installed Work as specified for testing.
5. Install equipment and materials in existing structures.

B. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. In areas of the building where new finishes are being provided, the patching required on a surface which is to receive a new finish will be to bring the underlying surface up to the finish required to receive the final finish. This contractor shall coordinate subsurface finish requirements with the finish trade contractor(s).

D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

E. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 CLEANING

A. This contractor shall be required to thoroughly clean all installed equipment, duct work and piping. Cleaning shall be required before substantial completion on any phase of the project. Do not use cleaning materials and agents that are hazardous to health or property or that may damage the finished surfaces.

END OF SECTION 22 00 10

SECTION 22 05 00 - COMMON WORK REQUIREMENTS - PLUMBING CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes materials and methods that are common to various Plumbing and Fire Protection Systems.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. 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 shelters.

F. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Mechanical sleeve seals.
2. Escutcheons.
3. Access Doors.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for all system items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F .

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Epco Sales, Inc.
c. Hart Industries, International, Inc.
d. Watts Industries, Inc.; Water Products Div.
e. Zurn Industries, Inc.; Wilkins Div.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Capitol Manufacturing Co.
b. Epco Sales, Inc.
c. Watts Industries, Inc.; Water Products Div.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150 psi minimum working pressure where required to suit system pressures.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.

2.4 FIRESTOPPING

A. The contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.

B. Subject to compliance with project requirements, firestopping materials may be provided by one of the following manufacturers:

1. Specified Technologies Inc. (STI) Somerville, NJ.
2. Tremco, Beechwood, OH.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Provide all required Cutting and Patching for all demolition and new construction work.

B. Provide cutting and patching where required for:

1. Removal and replacement of defective work.
2. Removal and replacement of work not conforming to requirements of the Contract Documents.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. 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, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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. Maintain unobstructed passageway of not less than 42” in width and 80” minimum head clearance as required by code.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. Install piping to permit valve servicing. Install piping at indicated slopes. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install piping to allow application of insulation.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install escutcheons for penetrations of walls, ceilings, and floors.

J. Seal annular space between sleeve or opening and pipe or pipe insulation, using sealants appropriate for size, depth, and location of joint.

K. Aboveground and Underground, Exterior-Wall Pipe Penetrations: Provide Mechanical Sleeve Seal and wall sleeve.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and sized per manufacturer’s recommendations. Position the pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at all pipe penetrations. Where required seal all pipe penetrations with fire stop materials.

M. Verify final equipment locations for roughing-in.

N. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

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 pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

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 unless dry seal threading is specified.
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.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 INSTALLATION OF PIPING UNDER EXISITNG FLOORS

A. Where the drawings indicate new piping is to be installed under existing slab-on-grade construction, the installing contractor will be required to verify the location(s) of any existing pipes, conduits or any other system components, that are required to remain in service, before saw cutting existing slabs.

END OF SECTION 22 05 00

SECTION 22 05 40 – GENERAL DUTY VALVES FOR PLUMBING 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. Ball valves.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

D. The installation and materials shall comply with the requirements of the 2015 International Plumbing Code and any applicable local code amendments. Verify code with requirements with the local code officials.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

B. Valve Sizes: Same as upstream piping unless otherwise indicated.

C. Valves in Insulated Piping: With stem extensions and the following features:

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
2. Butterfly Valves: With extended neck.

D. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

E. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Two-piece full-port, Brass Ball Valves with Brass Trim:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Stockham..

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.

2.3 BRONZE BALL VALVES

A. Full-Port, Bronze Ball Valves with Bronze Trim:

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

a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.

h. Stem: Bronze.

i. Ball: Chrome-plated brass.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.

END OF SECTION 22 05 40

SECTION 22 11 10 - DOMESTIC WATER 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 includes domestic water piping for above ground installations including accessories.

1.3 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Piping materials.

1.4 QUALITY ASSURANCE

A. The installation shall comply with the requirements of the 2015 International Plumbing Code (I.P.C.) and any applicable local code amendments. Verify the code with requirements with the local code official(s) before beginning the work.

B. All domestic water system components require third party certification as indicated in Chapter 3; Table 303.4 of the IPC.

C. All domestic water piping and fittings are required to bear the identification of the manufacturer as required in Chapter 3; paragraph 303.1 of the IPC.

D. Comply with NSF 61 for potable domestic water piping and components.

1.5 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt service to any portion of the existing occupied facilities until receiving permission. If interruption of the existing service is required, coordinate the work with the Owner and, if necessary, perform the work at a time, other than normal working hours, which is suitable to the owner.

PART 2 - RODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 PIPING JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.4 PIPING INSULATION

A. Mineral-Fiber Plumbing Pipe Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Products: Subject to compliance with requirements, provide Johns Manville Micro-Loc insulation or equal products manufactured by one of the following:

a. Knauf Insulation.

b. Owens Corning Fiberglas Insulation.

2. Type I, 850 deg. F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL.

3. Provide High-impact-resistant, UV-resistant PVC jacketed fitting covers complying with ASTM D 1784, Class 16354-C; Flame spread 25 or less; Smoke development 50 or less.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are 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. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas. Install exposed piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

C. Install piping adjacent to equipment and specialties to allow service and maintenance. Install piping to permit valve servicing.

D. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

B. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

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

3.3 VALVE INSTALLATION

A. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 3 and smaller. Use butterfly valves for piping NPS 3 and larger.

B. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.4 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.5 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump..

3.6 PIPE HANGER AND SUPPORT INSTALLATION

A. Support all domestic water piping in accordance with the 2015 International Plumbing Code or local code requirements.

B. Hangers shall be of materials that will not support galvanic action. Support piping with adjustable clevis hangers for all horizontal piping. Provide a 12” long 18 gage protective saddle for all clevis hangers that support insulated piping. Support each system independently of other piping systems, allowing for expansion of the pipe.

C. Install hangers for copper tubing with the following spacing:

1. NPS 1-1/4” and smaller: 6 feet maximum horizontal.
2. NPS 1-1/2” and larger: 10 feet maximum horizontal.
3. Install supports for vertical pipe at a maximum spacing of 10 feet.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to equipment and machines to allow service and maintenance.

B. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

3.8 IDENTIFICATION

A. Identify system components.

3.9 FIELD QUALITY CONTROL

A. Test systems according to procedures of authorities having jurisdiction or, in absence of such procedures, testing shall be per the requirements on the International Plumbing Code Section 312, Test And Inspections.

B. Piping Inspections: coordinate all inspection requirements with the Authorities Having Jurisdiction. Do not enclose, cover, or put piping into operation until it has been inspected and approved.

C. Domestic water piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 DISINFECTION OF POTABLE WATER SYSTEM(S)

A. All domestic water piping shall be purged and disinfected prior to utilization. The method to be followed shall be that required by the 2015 International Plumbing Code, Section 610, or the requirements of the local authorities. Prepare and submit reports of purging and disinfecting activities.

3.12 PIPING SCHEDULE

A. Aboveground domestic water piping, shall be the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) copper solder-joint fittings; and soldered, press-fit or grooved joints.
2. Provide insulation per materials indicated in Part 2

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.

END OF SECTION 22 11 10

SECTION 22 13 10 - SANITARY WASTE AND VENT 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 includes soil, waste, and vent piping inside the building.

1.3 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. The installation shall comply with the requirements of the 2015 International Plumbing Code (I.P.C.) and any applicable local code amendments. Verify the code with requirements with the local code officials before beginning the work.

C. All sanitary piping and fittings are required to bear the identification of the manufacturer as required in Chapter 3; 303.1 of the IPC.

D. Cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and shall be Third Party Tested per the requirements of the I.P.C.

1.5 FIELD CONDITIONS

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

1. Notify Owner no fewer than five days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Identification: Each length of pipe and each pie fitting, trap, fixture material and device utilized in a plumbing system shall bear the identification of the manufacturer.

B. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 74. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute® and listed by NSF® International. Pipe and fittings to be Service (SV) class.

B. Joints can be made using a compression gasket manufactured from an elastomer meeting the requirements of ASTM C 564 or lead and oakum.

C. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and applicable code requirements.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A 888 and CISPI Standard 301. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute ® and listed by NSF® International.

B. Hubless Couplings shall conform to ASTM C 1540 for heavy duty couplings. Gaskets shall conform to ASTM C 564.

C. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and applicable code requirements. Couplings shall be installed in accordance with the manufacturer's band tightening sequence and torque recommendations. Tighten bands with a properly calibrated torque limiting device.

2.4 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

1. Copper Drainage Fittings: cast copper or wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.

1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

C. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.

B. Aboveground, soil and waste piping NPS 5 and larger shall be:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel rigid, couplings; and hubless-coupling joints.

D. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.

E. Underground, soil, waste, and vent piping shall be:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

3.2 EXCAVATION AND BACKFILL

A. Provide all excavation and backfill required for underground piping installations. Perform excavation and backfill work conforming to the requirements of Section 306, Trenching, Excavation and Backfill, of the 2015 International Plumbing Code.

3.3 PIPING INSTALLATION

A. Install cast-iron sleeve with water stop and Mechanical Sleeve Seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight.

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

C. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

E. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.

G. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 VALVE INSTALLATION

A. Shutoff Valves: Install shutoff valve on each sewage pump discharge.

1. Install full-port ball valve for piping NPS 2 (DN 50) and smaller.
2. Install butterfly valve for piping NPS 2-1/2 (DN 65) and larger.

B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

C. Backwater Valves: Install backwater valves where indicated.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with the following requirements:

1. Vertical Piping: MSS SP-69, Type 8 clamps.
2. Horizontal Piping Runs: MSS SP-69, Type 1, adjustable, clevis hangers.

B. Install hangers for cast-iron soil piping with the following maximum horizontal spacing:

1. All sizes: 60 inches.
2. Spacing for 10-foot lengths, without fittings, may be increased to 10 feet.

C. Install supports for vertical cast-iron soil piping every 15 feet and at all floors.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches.
2. NPS 1-1/2 and larger: 120 inches.

E. Install supports for vertical copper tubing every 10 feet and at all floors.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.

3.8 FIELD QUALITY CONTROL

A. Test systems according to procedures of authorities having jurisdiction or, in absence of such procedures, testing shall be per the requirements on the International Plumbing Code Section 312, Test And Inspections.

B. Piping Inspections: coordinate all inspection requirements with the Authorities Having Jurisdiction. Do not enclose, cover, or put piping into operation until it has been inspected and approved.

C. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 13 10

SECTION 22 16 20 - NATURAL-GAS 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 includes natural gas piping, valves and accessories.

1.3 SUBMITTALS

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

1. Piping materials and specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
3. Pressure regulators. Indicate pressure ratings and capacities.

B. Welding certificates.

C. Operation and Maintenance Data: For gas valves and other accessories.

1.4 QUALITY ASSURANCE

A. The installation shall conform to the requirements of the 2015 International Fuel Gas Code and the requirements of the local utility company. Verify the code with requirements with the local utility before beginning the work.

B. Refer to the International Fuel Gas Code, Section 107, for the requirements of Inspections and Testing. Coordinate requirements with the applicable code officials and the utility company representatives.

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

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 and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to any portion of the existing occupied facilities until receiving permission. If interruption of the existing service is required,

coordinate the work with the Owner and, if necessary perform the work at a time, other than normal working hours, which is suitable to the owner.

1.7 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

C. Coordinate and schedule the main gas service installation with the local utility supplier. Prepare any permits and\or applications that may be required by the utility.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40.

1. Malleable-Iron Threaded Fittings: ASME B1.20.1.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding."
3. 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.

2.2 PIPING SPECIALTIES

A. 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 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (862 kPa).

B. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. 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.

2.4 MANUAL GAS SHUTOFF VALVES

A. Shut off valves are to conform to the requirements of the International Fuel Gas Code and the following standards, depending on gas pressure and application:

1. ANSI Z21.15.
2. ASME B16.44

3. ASME B16.33

B. General Requirements for Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
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 "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
6. Service Mark: Valves 1-1/4 inches (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Body: Bronze, complying with ASTM B 584.
2. Ball: Chrome-plated bronze.
3. Stem: Bronze; blowout proof.
4. Seats: Reinforced TFE; blowout proof.
5. Packing: Threaded-body packnut design with adjustable-stem packing.
6. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. CWP Rating: 600 psig (4140 kPa).
8. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
9. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
8. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
9. Overpressure Protection Device: Factory mounted on pressure regulator.
10. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
11. Maximum Inlet Pressure: 5 psig.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).

2. Combination fitting of copper alloy and ferrous materials.
3. Insulating materials suitable for natural gas.
4. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.7 LABELING AND IDENTIFYING

A. Provide pipe identification for all gas piping installed within the building. The identification markers shall have a yellow label with the word “GAS” marked in black letters. Spacing shall be per the requirements of the International Fuel Gas Code. Where there are two or more meters the piping for each system shall be labeled so that the piping system supplied by each meter is identifiable.

PART 3 - EXECUTION

3.1 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 5 PSIG

A. Aboveground branch piping shall be:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

3.2 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG

A. Aboveground Piping: Steel pipe with steel welding fittings and welded joints.

3.3 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Two-piece, full-port, bronze ball valves with bronze trim.

3.4 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are 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.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas. 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 above accessible ceilings to allow sufficient space for ceiling panel removal. Locate valves for easy access.

F. Install natural-gas piping with a slope conforming to the requirements of the International Fuel Gas Code. Install piping free of sags and bends. Install fittings for changes in direction and branch connections.

G. Install escutcheons at penetrations of interior walls, ceilings, and floors.

H. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials.

I. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

J. Extend relief vent connections to service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap. Where regulators or other devices requiring a vent connection are located on the outdoors, provide vent cap on the relief vent connection.

K. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

M. Connect branch piping from top or side of horizontal piping.

N. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

O. Do not use natural-gas piping as grounding electrode.

P. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

3.6 VALVE INSTALLATION

A. Install a manual gas shutoff valve, in an accessible location, at the gas connection to all gas fired equipment and/or gas fueled appliances. Shutoff valves to be installed per the following requirements:

1. The valve is to be located within the same room as the equipment.
2. The valve is to be located within 6’-0” of the equipment.
3. The valve shall be installed upstream of the union, connector or disconnect device.

B. Shutoff valves connected to emergency generators and other gaseous fueled equipment are to be installed per NFPA 37.

C. Install pressure regulators with maintenance access space that is adequate for servicing and testing of the regulator.

D. Install pressure regulators at locations suitable to the installation instructions provided by the connected equipment manufacturer. Verify requirements prior to installation.

3.7 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

B. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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.

C. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.8 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports shall conform to the requirements of MSS SP-58.

B. Support vertical piping at base and at each floor with a maximum spacing of 120”.

C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS ¾ and NPS 1: Maximum span, 96 inches.
2. NPS 1-1/4 and larger: Maximum span, 120 inches.

3.9 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

A. Provide Identification and Labeling of all gas piping systems and components as required by the International Fuel Gas Code.

B. Install detectable warning tape directly above gas piping, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below sub-grade under pavements and slabs.

3.11 FIELD QUALITY CONTROL

A. Perform all required tests and inspections. Refer to Section 406 of the International Fuel Gas Code for requirements.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

END OF SECTION 22 16 20

SECTION 23 00 10 - BASIC REQUIREMENTS – HVAC CONSTRUCTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The following Specification Section apply this specification section:

1. Bidding Requirements, Contract Forms and Conditions of the Contract.
2. Division 1 – General Requirements.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for HVAC installations. Administrative and procedural requirements are included in this Section and in Specification Sections indicated in 1.1.A.

1.3 PERMITS AND FEES

A. The contractor shall obtain and pay for all permits, inspection fees and licenses required by the local authority.

1.4 PROJECT SCHEDULE

A. Refer to the Bidding Requirements, Contract Forms and Conditions Of The Contract for the completion date and project construction schedule.

1.5 SHOP DRAWINGS AND SUBMITTALS

A. Follow the procedures specified in the applicable Division 1 specification sections and refer to individual sections of the Division 23 specifications for additional shop drawing and submittal requirements.

B. It is the responsibility of the contractor to thoroughly review any and all shop drawings prior to submission to the Architect/Engineer. The contractor's review shall include verifying conformance to the project documents. The contractor will also be responsible for verifying the quantities of materials are adequate.

C. All shop drawings shall be submitted with a cover sheet indicating the name of the project, the Architects and Engineers name, the name of the vendor and the contractor. There must be sufficient space on the title sheet to allow the appropriate stamping by both the Architect and the Engineer. Shop drawings and submittals not conforming to the above may be returned without review.

D. All shop drawing submittals will include a listing of any and all exceptions to the requirements indicated in the specifications and/or on the drawings. Where there are no exceptions, the submittals shall indicate such. Submittals that do not have this listing will not be reviewed.

1.6 COORDINATION DRAWINGS

A. Coordination drawings are required. Refer to applicable Division 1 specification section for the work required by this Contractor in preparing Coordination Drawings.

1.7 INSTALLATION ACCESSIBILITY

A. The installation of all equipment and appurtenances shall be completed so that access and clearances meet the requirements of the equipment manufacturer as well as the requirements of all applicable codes.

1.8 ACCEPTABLE MANUFACTURES

A. The design of the mechanical systems is based on the equipment manufacturer indicated on the drawings. Although individual sections of the specifications may list other manufacturers, these manufacturers will be accepted only if the following occurs:

1. Performance, as judged by the engineer, must be equal to the design based equipment.
2. Operating characteristics, as judged by the engineer, must be identical to those of the design based equipment.
3. Physical size of the equipment must be such that it can be installed in the available space, maintaining all required clearances for access/maintenance and meet the architectural requirements of the project such as installed height, length, width and operating weight. The contractor shall be responsible for verifying the equipment meets this requirement.
4. The contractor will be responsible for any costs associated for additional supports, changes in electrical wiring, piping changes, ductwork changes and / or controls that may be required if equipment other than the design based is used.

1.9 RECORD DOCUMENTS

A. Prepare record documents in accordance with applicable Division 1 specification sections. In addition to the requirements specified, indicate the following installed conditions:

1. Mains and branches of duct and piping systems, with valves, dampers and control devices, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Contract Modifications, actual equipment and materials installed.
5. Record Documents are to be prepared and/or revised to indicate the room names and numbers to be used by the owner after the projects is complete.

1.10 OPERATING AND MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with applicable Division 1 specification section.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. When materials and products are stored on site, provide protection from weather and temperatures that may cause damage to the items.

1.12 EXTRA MATERIALS

A. Various specification sections may indicate extra materials (filters, fan belts etc) that are to be provided with the respective equipment. Where indicated, the contractor shall provide the required extra materials. When directed by the owner's representative, the contractor shall install the extra filters in the respective equipment. If no additional installation is required, the contractor shall forward all extra materials to the owner and obtain a receipt for any materials forwarded.

B. The contractor shall also provide a list of all filters sizes for each type and size of unit provided on the project.

PART 2 - PRODUCTS

2.1 Not Applicable.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Obtain equipment shop drawings for the various items that require rough-in.

3.2 MECHANICAL INSTALLATIONS

A. Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.
2. Verify all dimensions by field measurements.
3. Coordinate requirements for chases slots, and openings in other building components during the progress of construction, to allow for mechanical installations.
4. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
5. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
6. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
7. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
8. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
9. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
10. Install systems, materials, and equipment giving right-of-way priority to the systems required to be installed at a specified slope.
11. Seal all places where piping or ducts pass through walls and floors.

3.3 CUTTING AND PATCHING

A. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.
2. Removal and replacement of defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Remove samples of installed Work as specified for testing.
5. Install equipment and materials in existing structures.

B. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. In areas of the building where new finishes are being provided, the patching required on a surface which is to receive a new finish will be to bring the underlying surface up to the finish required to receive the final finish. This contractor shall coordinate subsurface finish requirements with the finish trade contractor(s).

D. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

E. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4 CLEANING

A. This contractor shall be required to thoroughly clean all installed equipment, duct work and piping. Cleaning shall be required before substantial completion on any phase of the project. Do not use cleaning materials and agents that are hazardous to health or property or that may damage the finished surfaces.

END OF SECTION 23 00 10

SECTION 230500 – COMMON WORK REQUIREMENTS – HVAC CONSTRUCTION

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 materials and methods that are common to various HVAC s installations.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. 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 shelters.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.
2. Escutcheons.
3. Access Doors.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services,

circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

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

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Pipe wall penetration seals to be of the modular link type. Seals shall consist of a series of interlocking, molded synthetic rubber links, with heavy-duty plastic pressure plates, and corrosion resistant nuts and bolts. Seals to be designed to provide a hydrostatic seal between the pipe and wall penetration. Seals shall be sized and selected per manufacturer recommendations. Mechanical pipe seals shall be fabricated of an EPDM elastomer for general service and a Nitrile/ Buna-N for hydrocarbon/petroleum based applications. Provide stainless steel hardware as required.

B. Steel wall sleeve: Cast in place concrete wall sleeves to be fabricated from galvanized heavy wall welded or seamless carbon steel pipe. All sleeves to have a 2" wide, full perimeter water stop, welded on both sides.

C. Mechanical pipe seals and wall sleeves shall be manufactured by The Metraflex Company®, or Flexicraft Industries.

2.5 SLEEVES

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

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

2.7 CONCRETE EQUIPMENT BASES

A. Minimum compressive strength: 3500 p.s.i. at 28 days.

B. Minimum cementitious material content: 520 lb/cu. Yd.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

2.9 FIRESTOPPING

A. The contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. All firestopping shall meet the requirements of ASTM E-814 and UL 1479. Firestopping for ducts shall be installed with materials and methods identified in UL Ventilation Duct Assemblies (HNLJ), V Series as applicable to the wall assembly specified.

B. Subject to compliance with project requirements, firestopping materials may be provided by one of the following manufacturers:

1. Specified Technologies Inc. (STI) Somerville, NJ.
2. Tremco, Beechwood, OH.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. 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, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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. Where piping and ducts are exposed in areas such as mechanical rooms and boiler rooms the installation shall an unobstructed passageway of not less than 42” in width and 80” minimum head clearance, as required by code.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. Install piping to permit valve servicing. Install piping at indicated slopes. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping and pipe supports to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install escutcheons for penetrations of walls, ceilings, and floors.

K. Sleeves are not required for core-drilled holes.

L. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor slabs.

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 (50 mm) above finished floor level.

2. Install sleeves in all new walls and floor slabs as walls and slabs are constructed.

3. Install sleeves that are large enough to provide sufficient annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint.

M. Aboveground and Underground, Exterior-Wall Pipe Penetrations: Provide Mechanical Sleeve Seal and wall sleeve.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and sized per manufacturer's recommendations. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at all pipe and duct penetrations. Where required seal all pipe and duct penetrations with firestop materials.

O. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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 pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. 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 unless dry seal threading is specified.

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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment to maintain unobstructed passageway of not less than 42” in width and 80” minimum head clearance as required by code.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment to allow right of way for piping installed at required slope.

3.5 CONCRETE EQUIPMENT BASES

A. Provide concrete bases for all floor mounted mechanical equipment unless otherwise noted on the contract drawings.

1. Construct concrete bases with a minimum height of 6” and extend bases not less than 6” larger, in all directions, than supported equipment.
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 and according to anchor-bolt manufacturer's written instructions.
6. Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project when applicable.

3.6 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout.

B. Provide forms as required for placement of grout. Avoid air entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment.

C. Place grout around anchors. Cure placed grout.

END OF SECTION 230500

SECTION 230530 - METERS AND GAUGES - HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes: Thermometers, Gauges, Test plugs and accessories.

1.3 SUBMITTALS

A. Submit Product Data for type of product.

B. Provide operation installation and maintenance data.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide fully adjustable angle thermometers by one of the following:

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
5. Miljoco Corporation.

B. Case: Cast aluminum with dark blue epoxy coating, 9 inches long.

C. Window: Clear acrylic for temperatures up to 300 deg. F; glass for higher temperatures.

D. Tube: blue reading, organic filled.

E. Window: Clear acrlylic.

F. Stem: brass for thermowell installation and of length to suit installation.

G. Accuracy: Plus or minus 1 scale division.

2.2 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, brass construction, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAUGES

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

1. Palmer - Wahl Instruments Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
5. Miljoco Corporation.

B. Dial-Type Pressure Gauges: Indicating-dial type complying with ASME B40.100.

1. Case: Liquid-filled type, fiberglass reinforced polypropylene, 4-1/2-inch diameter, solid front, blow-out back.
2. Pressure-Element Assembly: Bronze tube.
3. Pressure Connection: Brass, NPS ¼ or ½".
4. Movement: Stainless steel rotary type with stainless steel bushings.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red or other dark-color metal.
7. Window: Acrylic plastic.
8. Accuracy: plus or minus .5 percent range.
9. Vacuum-Pressure Range: 30-in. Hg of vacuum to 150 psig of pressure.
10. Range for Fluids under Pressure: Two times operating pressure.
11. Temperature range: 250 deg. F for heating systems; 150 Deg. F for all other hydronic systems.

C. Pressure-Gauge Fittings:

1. Valves: NPS 1/4 brass or stainless-steel needle type valve.

2.4 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements provide test plug (PT Plug) products by one of the following:

1. Flow Design, Inc.
2. Peterson Equipment Co., Inc.
3. Sisco Manufacturing Co.
4. Trerice, H. O. Co.
5. Watts Industries, Inc.; Water Products Div.

B. Description: Ports are to be suitable to accept thermometer stem or pressure gauge adapter and shall have dual EPDM internal seals, threaded brass cap with metal retainer strap. Ports are to be adequate length and suitable for installation in insulated or non insulated piping.

C. Construction: Brass body with dual EPDM seals.

D. Minimum Pressure and Temperature Rating: 1000 psig at 270 deg. F.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install thermometers where indicated on the drawings, see plans and detail drawings.

B. Provide the following temperature ranges for thermometers

1. Heating Hot Water System: 30 to 240 deg. F, with 2-degree scale divisions.

3.2 GAUGE APPLICATIONS

A. Install pressure gauges where indicated in other Division 23 Sections and where indicated on the drawings plans and detail drawings.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

C. Install pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

D. Install shut-off needle-valve and snubber fitting in piping for each pressure gauge and thermometer.

E. Install test plugs in tees in piping.

3.4 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance for meters, gauges, machines, and equipment.

3.5 ADJUSTING

A. Calibrate meters according to manufacturer’s written instructions, after installation.

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

END OF SECTION 230530

SECTION 230540 – GENERAL DUTY VALVES - 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. This section includes various types of general duty valves used in HVAC systems.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of valve from the same manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping per the manufacturer’s recommendations and to prevent damage during shipping.

B. Store valves per the manufacturer’s recommendations.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to Part 3 for HVAC valve schedule and applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves:

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

a. Conbraco Industries, Inc.
b. Crane Co.; Crane Valve Group.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Manufactured to comply with standard MSS SP-110.
b. Rated for 150 psig SWP and 600 psig CWP.
c. Two-piece cast bronze body.
d. Seats: TFE.
e. Anti-blowout stem and chrome plated bronze ball.

3. Where valves are to be installed in insulated piping, provide extended handles with memory stop, and made of a non-thermal conductive material. Provide a protective sleeve to allow operation of the valve without damaging the insulation.

2.3 BUTTERFLY VALVES

A. Cast-iron body butterfly Valves:

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

a. Conbraco Industries, Inc.
b. Crane Co.; Crane Valve Group.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co, Inc.

2. Description:

a. Manufactured to comply with MSS SP-67.
b. 200 PSI CWP Rating.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron.
e. Seat: EPDM.
f. Stem: 400 series stainless steel.
g. Disc: Aluminum bronze.
h. Operation: 6” and smaller, 10 position lever operator; 8” and larger gear operator.

3. Where valves are to be installed in insulated piping, provide extended neck.

2.4 HIGH PERFORMANCE BUTTERFLY VALVES

A. Class 150 Butterfly valve.

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

a. NIBCO model LCS 6822 or equal.
b. Victaulic model Vic 300 Master Seal with Grade E EPDM high temperature seat.

2. Description:

a. Manufactured to comply with MSS SP-68.

b. Class 150.
c. 250 degree rating at 200 PSI
d. Carbon steel body with stainless steel disc and stem.
e. PTFE seats.
f. Permanently lubricated 316 stainless steel bearings.
g. Operation: 6” and smaller, lever (locking) operator; 8” and larger gear operator.

3. Where valves are to be installed in insulated piping, provide extended neck.

2.5 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

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

a. Crane Co.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Manufactured to comply with MSS SP-67.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: bronze.
e. Disc: bronze.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.

2.7 IRON, GROOVED-END SWING CHECK VALVES

A. 300 CWP, Iron, Grooved-End Swing Check Valves:

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

a. Anvil International, Inc.
b. Victaulic Company.

2. Description:

a. CWP Rating: 300 psig.
b. Body Material: ASTM A 536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring operated, ductile iron or stainless steel.

2.8 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Description:

a. Standard: MSS SP-78, Type II.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
d. Plug: Cast iron or bronze with sealant groove.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball or butterfly valves.
2. Throttling Service except Steam: Ball, or butterfly valves.
3. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with **bronze** disc.
b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, **resilient**-seat check valves.

B. High Performance Valve locations are noted on the contract drawings.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

END OF SECTION 230540

SECTION 23 05 70 - IDENTIFICATION FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following identification materials:

1. Equipment markers.
2. Pipe markers.
3. Duct markers.
4. Valve tags.
5. Valve schedules.
6. Warning tags.

B. Refer to other Division 23 Specification Sections for requirements to label and identify materials, equipment and accessories relating to other components of the HVAC System(s).

1.3 SUBMITTALS

A. Submit Product Data for type of marker and tag along with a schedule where each type will be installed.

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 location of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Provide identification materials available through Craftmark Pipe Markers or equal.

2.2 EQUIPMENT MARKERS

A. Equipment Markers: 1/8” thick black plastic tag with engraved data in white letters, pre-drilled holes for permanent attachment on equipment.

1. Minimum marker size: 4” wide by 2” high. Length and width to be larger if required for marker content.
2. Minimum letter size: ½”.

3. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate material.
4. Marker content: equipment name tag as shown on the drawings (i.e. AHU-1).

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured self-adhesive pipe markers: Preprinted, color-coded, with lettering indicating service, and showing direction of flow. Provide markers for all piping systems.

1. Colors: Comply with ASME/ANSI A13.1.
2. Lettering: Use standard piping system terms and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

2.4 DUCTWORK IDENTIFICATION

A. Manufactured self adhesive vinyl peel off markers, 4” x 24” with bold 2” letters. Include direction airflow, duct service (such as supply, return, and exhaust and air handling system identification (i.e. AHU-2 SUPPLY AIR).

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and ½-inch numbers, with numbering scheme reviewed and approved by the owner’s representative. Provide 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick brass.
2. Valve-Tag Fasteners: Brass wire-link or beaded chain.

2.6 VALVE SCHEDULES

A. Valve Schedules: For each piping system, on standard-size 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-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
2. Frame: Extruded aluminum.
3. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment markers on each major item of HVAC equipment. Locate nameplates where accessible and visible. Nameplates are not required for HVAC equipment that is exposed to view in finished areas such as corridors, stairs, offices and classrooms. Include nameplates for the following general categories of equipment:

1. Pumps.
2. Boilers.
3. Heat Exchangers.
4. Air Handling Units.

3.2 PIPING IDENTIFICATION

A. Locate pipe markers where piping is above accessible ceilings, exposed in machine and \ or equipment rooms and in maintenance spaces such as shafts, tunnels, and plenums 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 non-accessible 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 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.3 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts according to the following:

1. Supply ducts.
2. Return ducts.
3. Outside air intake ducts.
4. Exhaust ducts.

B. Locate duct markers where ducts are above accessible ceilings, exposed in machine and\or equipment rooms and in maintenance spaces such as shafts, tunnels, and plenums as follows:

1. Near each branch connection.
2. Near penetrations through walls, floors, ceilings, and non-accessible enclosures.
3. At access doors and similar access points.
4. Near major equipment items and other points of origination and termination.
5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.4 VALVE-TAG INSTALLATION

A. Install tags on all valves and control devices valves and control devices in all piping systems. List all tagged valves in a valve schedule.

B. Valve-Tag Application Schedule:

1. Valve-Tag Size and Shape for all piping systems:
   a. 1-1/2 inches, round.
2. Valve-Tag Color: Natural.

C. The location of all valves shall be indicated by locator tags on the ceiling tile. Provide equipment locator tags in a color suitable to the owner. Tags to be push tack type with 7/8” diameter head as manufactured by Marketing Services Inc. or equal.

3.5 VALVE-SCHEDULE INSTALLATION

A. Mount valve schedule on wall in accessible location in each major equipment room. Provide a complete valve schedule in the O and M manuals.

END OF SECTION 23 05 70

SECTION 23 06 00 - HVAC SYSTEM TESTING, ADJUSTING, AND BALANCING

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. Testing, Adjusting and Balancing (TAB) work is to be provided a qualified TAB firm and shall be part of the HVAC Contractor’s work.

B. Work under this section includes, but is not limited to, Testing, Adjusting and Balancing (TAB) of the nes and modified air systems, water systems and HVAC equipment:

C. All TAB work shall comply with the requirements of TAB procedures required by the Associated Air Balancing Council, National Environmental Balancing Bureau and ASHRAE.

D. Coordinate and witness the installation work of the HVAC Contractor including all sub-contractors working for the HVAC Contractor and Electrical Contractor. Provide progress inspections of the work to ensure the installation of all systems is progressing as required and will operate as specified when completed. Report results of the progress inspection to the Owner's Representative.

E. Submit balancing reports for all air and water systems.

F. Validate the start-up and operation of all HVAC equipment and systems by the HVAC Contractor.

G. Validate the start-up and operation of the HVAC Controls system. Submit reports indicating the operation of all equipment, throughout the range of operation, meets the requirement of the Sequence of Operations.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

1.4 SUBMITTALS

A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified herein.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by NEBB or AABC in the testing, adjusting and balancing of both air and water systems. The firm shall guarantee that all work will be performed in accordance with the applicable NEBB / AABC standards and procedures, and evidence of the firm's certification shall be provided for the engineer or designated owner's representative.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

C. The TAB firm shall have a minimum of 5 years of experience with projects of a similar size and scope. Submit TAB firm qualifications within 30 days of the notice to proceed.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and portions of the existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations. Review the project's construction phasing plan and provide the necessary number of TAB visits to comply

PART 2 - PRODUCTS

2.1 DUCT ACCESSORY HARDWARE

A. Instrument Test Ports: 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 the specified eternal duct insulation thickness. Provide special gaskets where test holes are to be installed in round or oval ducts. Test Ports to be Duro-Dyne model TH1, IP2 and/or IP4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

B. Refer to the Contract Drawings for notes that relate to balancing of the air and water systems.

C. Examine the approved shop drawing submittals for all HVAC systems and equipment prior to starting the TAB work.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section Metal Ducts, and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Verify all systems are complete, including controls, before starting the TAB work.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in the applicable NEBB or AABC standards.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors where required.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish to meet the requirements of the installation.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. For variable-air-volume systems, develop a plan to simulate diversity.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

K. Where required, verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

L. Install instrument test holes in ducts at all required locations for testing and balancing purposes.

M. Air Handling Unit(s) filters: Provide verification of controls and provide set points for monitoring the filter pressure drop in all air handling units where indicated in Specification Section 230905 HVAC Sequence of Operation. Provide adjustment when necessary.

N. Building Pressurization: Provide verification of controls and provide set points for building pressurization control in various systems as indicated in Specification Section 230905 HVAC Sequence of Operation. Provide adjustment when necessary.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow. Measure air flows in main ducts and at terminal outlets and inlets.

2. Measure fan static pressures as follows to determine actual static pressure:

   a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

   a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of branch ducts.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Re-measure each branch duct after all have been adjusted. Continue to adjust branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents. Adjust patterns of adjustable outlets for proper distribution without drafts.

E. Measure and verify ventilation air flows are as indicated on the equipment schedules.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved. Monitor motor performance during procedures and do not operate motors in overload conditions.
3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Provide locations of piping system pressure sensors to be installed in variable flow piping systems. Review the piping system layout for each system. Provide an initial pressure setting and adjust the final setting as required, when balancing is complete.

B. Balance systems with automatic, two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.9 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.10 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check settings and operation of safety and relief valves. Record settings.

3.11 PROCEDURES FOR HYDRONIC BOILERS

A. Perform testing, adjusting and balancing during the heating season. Measure and record entering- and leaving-water temperatures and water flow rates for all boilers. Measure and record the following data with each boiler operating at design conditions:

1. For systems with multiple boilers verify flow rates through each boiler meets the minimum flow rates established by the boiler manufacturer. Adjust and set the minimum flow rates for the boiler pumps.

2. Entering and leaving temperatures, pressure drop, and water flow rates in the common boiler loop.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.13 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following general data:

1. Title page.
2. Name and address of the TAB contractor.

3. Project name and location.
4. Architect's and Engineer's name and address.
5. Contractor's name and address.
6. Report date.
7. Signature of TAB supervisor who certifies the report.
8. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
9. Summary of contents.
10. Data for terminal units, including manufacturer's name, type, size, and fittings.
11. Notes to explain why certain final data in the body of reports vary from indicated values.
12. Test conditions for fans and pump performance forms.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm.
b. Total system static pressure in inches w.g.
c. Fan rpm.
d. Discharge static pressure in inches w.g.
e. Filter static-pressure differential in inches w.g.
f. Dirty filter setpoint.
g. Preheat-coil static-pressure differential in inches w.g.
h. Cooling-coil static-pressure differential in inches w.g.
i. Heating-coil static-pressure differential in inches w.g.
j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air damper position.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches and bore.
h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches w.g.
c. Fan rpm.
d. Discharge static pressure in inches w.g.
e. Suction static pressure in inches w.g.

G. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg. F.
d. Duct static pressure in inches w.g.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

H. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Air flow rate in cfm.
b. Entering-water temperature in deg. F.
c. Leaving-water temperature in deg. F.

d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg. F.
f. Leaving-air temperature in deg. F.

I. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

J. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.14 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing is complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, submit the final report for review.
2. The **Owner may** select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
3. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 06 00

SECTION 230700 - HVAC SYSTEM 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 insulation materials and accessories for insulating HVAC system piping, ductwork, and equipment.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Duct and pipe insulation, including adhesives, shall have a flame spread index not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84 or UL 723, using the procedures of ASTM E2231. Duct coverings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C 411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250 degrees F.

B. All insulation values are to meet the requirements of the applicable edition of the International Energy Conservation Code.

C. Insulation installed on the exterior of ducts, located within the building, shall bear identification at intervals not greater than 36“ with the name of the manufacturer, the R value at the specified installed thickness and the flame spread and smoke developed indexes of the composite materials.

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. Store materials providing protection from the elements.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with the duct and piping.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials. Insulation conductivity (k) shall not exceed 0.27 Btu per inch/h – ft2 – deg. F.

1. Products: Subject to compliance with requirements, provide products manufactured by one of the following:
   a. Armacell LLC; AP Armaflex.
   b. Aeroflex USA Inc.; Aerocel.

B. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1136 with factory-applied FSK jacket. Insulation conductivity (k) shall not exceed 0.27 Btu per inch/h – ft2 – deg. F.

1. Products: Subject to compliance with requirements, provide Johns Manville Microlite insulation or equal products manufactured by one of the following:
   a. CertainTeed Corp.; Duct Wrap.
   b. Knauf Insulation; Duct Wrap.
   c. Owens Corning; All-Service Duct Wrap.

C. Mineral-Fiber, Preformed Pipe Insulation:

1. Subject to compliance with requirements, provide Johns Manville Micro-Lok insulation or equal products manufactured by one of the following:
   a. Knauf Insulation; 1000 Pipe Insulation.
   b. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL.

3. Provide High-impact-resistant, UV-resistant PVC jacketed fitting covers complying with ASTM D 1784, Class 16354-C; Flame spread 25 or less; Smoke development 50 or less.

D. Mineral-Fiber Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied FSK jacket.

1. Subject to compliance with requirements, provide Johns Manville Micro-Flex insulation or equal products manufactured by one of the following:
   a. Knauf Insulation; Pipe and Tank Insulation.
   b. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 CEMENTS, ADHESIVES, SEALANTS AND MASTICS

A. Provide all required types of cements, adhesives, sealants, mastics and other accessories required to install all insulation materials and systems. Prepare surfaces as required by the insulation manufacturers. Install cements, adhesives, sealants and mastics per manufacturer’s recommendations.

2.3 PVC JACKETING

A. PVC jacketing, 30 mil thickness with flame spread of 25 or less and a smoke development of 50 or less. Temperature rating 150 degrees F.
   1. Subject to compliance with requirements, provide Johns Manville Zeston Jacketing or equal.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes per the manufacturer's instruction with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe 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. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. 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.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

L. Install insulation with factory-applied jackets per manufacturer's instructions.

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

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

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.2 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations. Seal penetrations with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

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

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

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies.

3.3 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Equipment, Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Stagger joints between insulation layers at least 3 inches (75 mm).

B. Flexible Elastomeric Thermal Insulation Installation for Equipment, Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Union and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

1. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
2. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves,

insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

3. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

4. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

5. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

6. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

7. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

B. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.5 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with adhesives to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulate all pipe fittings, elbows, valves and pipe specialties.

C. Apply weather resistant coating on all exterior insulation to protect the insulation from ultraviolet rays. Provide Armaflex WB Finish water based coating or equal.

3.6 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes per manufacturer’s instructions. Where vapor barriers are required, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings, Elbows, Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

C. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins, apply adhesives according to manufacturer's recommended coverage rates per unit area.

1. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
2. 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.
3. 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.

D. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins. Apply adhesives according to manufacturer's recommended coverage rates per unit area.

1. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal. 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.
2. 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.

3.7 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Supply air ducts, coils and plenums located above ceilings, shall be insulated with:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density; “R” value 6.3; with vapor barrier having a maximum permeance of 0.05 perm.

B. Return air ducts and plenums located above ceilings, shall be insulated with:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density; “R” value 6.3; with vapor barrier with vapor barrier having a maximum permeance of 0.05 perm.

C. Outdoor air ducts and plenums located above ceilings, shall be insulated with:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density; “R” value 8.3; with vapor barrier with vapor barrier having a maximum permeance of 0.05 perm.

D. Exposed supply-air ducts and plenums shall be insulated with:

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

E. Exposed return-air ducts and plenums shall be insulated with:

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

F. Exposed outdoor-air ducts and plenums shall be insulated with:

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

3.8 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Heat-exchanger water-to-water for heating service insulation shall be:

1. Mineral-Fiber Pipe and Tank: **2 inches** thick.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water Piping:

1. All Pipe Sizes: Insulation shall be Flexible Elastomeric: 3/4 inch thick.

B. Make-up Water:

1. All sizes: Insulation shall be Mineral-Fiber, 1 inch thick with vapor barrier.

C. Heating-Hot-Water Supply and Return:

1. NPS 1 ½ inches and smaller, insulation shall be:

a. Mineral-Fiber: 1½ inches thick.

2. NPS 2 inches and larger, insulation shall be:

a. Mineral-Fiber: 2 inches thick.

END OF SECTION 23 07 00

SECTION 23 09 00 – HVAC CONTROLS

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 other HVAC Specification Sections which describe the requirements of the HVAC system components.

C. Refer to Section 230905: Sequence of Operation, for information related to the system controls.

1.2 SUMMARY

A. All control work will be completed by Trane under a separate contract directly with the owner. The BMS shall be an extension to the existing Trane control system currently being upgrading within this building.

B. This section is included for coordination and reference only.

C. This Section includes direct digital control (DDC) equipment for control of HVAC systems and various other systems. Refer to all Division 23 specification sections for controls that may be provided with the associated equipment. Provide all required controls and accessories to accomplish the method of control as indicated in Section 230905, Sequence of Operation. The following HVAC equipment shall be controlled:

1. Boiler(s) systems.
2. Hydronic system pumps.
3. Hydronic freeze pumps.
4. Exhaust fans.
5. Gravity Ventilators.
6. Heat exchangers.
7. Air handling units.
8. Hydronic duct coils.
9. Unit heaters, cabinet heaters and other terminal heating units.
10. Variable frequency drives.
11. Sequence(s) that may be indicated on the construction drawings.

D. The BMS manufacturer/supplier shall be responsible for all BMS control and power wiring for a complete and operable system. All wiring shall be done in accordance with all applicable local, state and national codes.

1.3 DEFINITIONS

A. DDC: Direct Digital Control

B. BMS: Building Management System.

C. BAS: Building Automation System.

D. EMS: Energy Management System.

E. PC: Personal computer.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

B. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

C. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

D. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

E. Shop Drawings: Provide detailed equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include the following:

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
3. Wiring Diagrams: Power, signal, and control wiring.
4. Details of control panel faces, including controls, instruments, and labeling.
5. Written description of sequence of operation.
6. Schedule of dampers including size, leakage, and flow characteristics.
7. Schedule of valves including flow characteristics.
8. DDC hardware including:
    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
10. Controlled Systems including:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.

F. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

5. Software license required by and installed for the workstations and control systems.

6. All system and software development tools are to allow the owner to independently maintain the s6ystem.

7. Software Tools - All software tools needed for full functional use, including programming of BCs, BACnet controllers, network management and expansion, and graphical user interface development, of the BAS described within these specifications, shall be provided to the owner or his designated agent. Any licensing required by the manufacturer now and into the future, including changes to the licensee of the software tools, and the addition of hardware corresponding to the licenses, shall be provided to allow for a complete and operational system for both normal day to day operation and servicing shall be provided. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.

8. Programming Tools - Provide freely available Niagara AX Wizards to facilitate the programming and configuration of all of the BACnet devices that are provided for the HVAC and lighting control. Wizards shall be provided free of charge and be compatible with the current published versions of the network management tool that is provided as part of this project. The wizard software shall be available for public access from the manufacturer's web site. These wizard programming tools shall be compatible with at least 3 other brands of the Niagara Framework network management tools. The SI shall demonstrate as part of their prequalification as to how they intend to comply with these requirements.

G. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:

1. Interconnection wiring diagrams with identified and numbered system components and devices.

2. Keyboard illustrations and step-by-step procedures indexed for each operator function.

3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

4. Calibration records and list of set points.

1.5 SYSTEM PERFROMANCE

A. System shall have an open architecture utilizing the data infrastructure of fiber optic cables and/or copper cables to communicate between field panels.

B. System server shall include the latest edition of Microsoft© windows operating system. Provide web-based browser graphic software to integrate the systems. System must be accessible remotely via the internet.

C. Graphic software shall reside on the system server. The intent of the specification is to provide a BMS system operating with a Niagara 4 open framework which is truly open at all levels. Open by definition includes Sourcing, Product, Service and Expansion. Any contractor or integrator certified on Niagara 4 platform must be able to work on any device, network controller or supervisor without having to use other vendors to access any part of the BMS network.

D. The graphic software shall provide a graphical representation of the building floor plan with icons/images to indicate HVAC system components and readings, generator annunciation, power metering information and locations and exterior lighting control. System software must interface with the separate systems to report activities by date, time.

E. System shall log events for report trends, alarm conditions, etc through the Niagara software.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. 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.

C. UL listed to Standards UL864 (Fire), UL2017 (Signaling Systems), UL916 (Energy Management Systems), UL1017 (Security), UL1610 (Central Station) and UL 294 (Access Control).

1.7 CODES AND STANDARDS

A. Meet the requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

B. Underwriters Laboratories: Products shall be UL-916-PAZX listed.

C. Federal Communications Commission -- Part J.

D. ASHRAE/ANSI 135-2016 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

E. ASHRAE/ANSI 135-2016 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification in order to improve interoperability with various building system manufacturers' control systems and devices.

F. EIA-709.1 LonTalk Standard and EIA 901.2 (LonMark Certification) - (Unit Level Devices) - Custom Application Controllers and Application Specific Controllers shall use FTT-10A transceivers and support the LonTalk communication protocol utilizing Standard Network Variable Types (SNVT) as defined by Echelon Corporation. This standard communication protocol provides interoperability with hundreds of other various building system manufacturers' control systems and devices.

1.8 DELIVERY, STORAGE AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

1.10 WARRANTY

A. The BMS supplier/installer shall warrant all work per the following:

1. All control systems labor, equipment and materials shall be warranted to be free from defects for a period of twelve (12) months after the date of substantial completion. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BMS manufacturer/installer shall respond to the Owner's request for warranty service within 24 hours of the initiated call.

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BMS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

3. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.

PART 2 - PRODUCTS

2.1 DDC EQUIPMENT

A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

   a. Global communications.

   b. Discrete/digital, analog, and pulse I/O.

   c. Monitoring, controlling, or addressing data points.

   d. Software applications, scheduling, and alarm processing.

   e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, anti-short cycling, PID control, DDC with fine tuning, and trend logging.

   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.

   c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing when applicable.

   d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.

   e. Remote communications.

   f. Maintenance management.

   g. Units of Measure: Inch-pound.

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

B. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.
2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position auto-manual switch, and manually adjustable potentiometer].
6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

C. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

D. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.2 BUILDING CONTROLLERS

A. There shall be one or more independent, standalone microprocessor-based System Controllers to manage the global strategies described in Application and Control Software section.

B. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.

C. The controller shall provide a USB communications port for connection to a PC.

D. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

E. All System Controllers shall have a real time clock.

F. Data shall be shared between networked System Controllers.

G. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

1. Assume a predetermined failure mode.

2. Generate an alarm notification.

3. Create a retrievable file of the state of all applicable memory locations at the time of the failure.

4. Automatically reset the System Controller to return to a normal operating mode.

H. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40° F to 122° F.

I. Clock Synchronization:

1. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.

2. All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.

3. All System Controllers shall automatically adjust for daylight savings time if applicable.

J. Serviceability:

1. Provide diagnostic LEDs for power, communications, and processor.

2. The System Controller shall have a display on the main board that indicates the current operating mode of the controller.

3. All wiring connections shall be made to field removable, modular terminal connectors.

4. The System controller shall utilize standard DIN mounting methods for installation and replacement.

K. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.

L. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shut-down below 80% nominal voltage.

M. Uninterruptible Power Supply: 1.5kVA. Provide 30 mins of backup power after loss of power.

N. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

2.3 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

B. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72 hour battery backup.

C. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

D. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

E. BACnet Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.

F. Enclosure: Waterproof rated for operation at 40 to 150 deg F.T

2.4 PROGRAMABLE CONTROLLERS

A. Performance - Each PC shall have a minimum of 64K of Non-volatile Flash memory for control applications and 128K non-volatile flash memory for storage with an 8 bit processor. The PC shall have a minimum ambient operating temperature range of -0°C to 70°C or 32°F to 158°F.

B. Inputs - Analog inputs shall have the following minimum level of performance: 16-bit A to D resolution; allow monitoring of platinum 100 ohms, platinum 1000 ohm, nickel 1000 ohms, thermistor 10K type II, thermistor 10K type III, voltage input0-10VDC, current input 4-20mA, digital input, pulsed input minimum 2 Hz.

C. Outputs - Outputs shall be either software configurable to be either analog or digital or dedicated digital only - Analog outputs shall be selectable as voltage of 0-10 VDC (linear) or 4-20mA or Digital outputs shall be 0-12 VDC (off/on), floating or PWM. Outputs shall have an adjustable range of 2 seconds to 15 minutes. Output Resolution shall be a minimum 8 bits digital/analog converter. All individual outputs and power supply shall be protected by an auto reset fuse. There shall be an LED status indicator on each of the outputs.

D. Programmable Controller Features:

1. Provide an onboard network communication jack.
2. The PC shall be provided with a diagnostic indicator lights for power and network communication of transmit and receive along with a light indication position for each output.
3. Hand/Off/Auto Switches - For all controllers applied to an AHU, Chiller, Pumps, Cooling Tower or Boiler, provide for the manual override and adjustment of all Analog and Digital outputs through a three-position switch giving the selection of Hand, Off and Auto (HOA). A HOA shall be provided for each separate digital and analog output from the controller and be an integral part of the controller. HOA switches external from the controller shall not be accepted. For the Analog outputs the Hand position of the switch shall provide for the adjustment of the output signal through a linear scaled potentiometer. The position of the HOA shall be monitored and an alarm shall be delivered to the Graphical User Interface should the switch be in an Off or Hand position. An indicating LED shall be provided on the controller for each HOA indicating position of the switch. For all Analog outputs, the indicating LED shall provide a linear indication of the position of the Potentiometer through a variation in the intensity of the indicator LED and be provided as a numerical value that can be viewed at the Graphical User Interface.
4. Enclosures - Provide for a plastic enclosure with a separate back plate with terminals such that the electronic portion of the controller can be easily removed for ease of installation and servicing.

E. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

2.5 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Humidity Sensors: Bulk polymer sensor element.

1. Accuracy: 2 percent full range with linear output.
2. Room Sensor Range: 20 to 80 percent relative humidity.
3. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    a. Sep-point adjustment.

b. Set-point indication.

c. Provide standard manufacturers color to be selected.

4. Duct sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.

5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.

6. Humidity sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

C. Static pressure transmitters: non-directional sensor with suitable range for expected input, and temperature compensated.

1. Accuracy: 2 percent full range with repeatability of 0.5 percent.
2. Output: 4 to 20 mA.
3. Building Static-Pressure Range: 0- to 0.25-inch wg.
4. Duct Static-Pressure Range: 0- to 5-inch wg.

D. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure.

E. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig.

F. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

G. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system.

2.6 ROOM TEMPERATRURE SENSORS

A. Room Temperature Sensor: sensor shall be of the resistance / thermistor type. Accuracy shall be +/- 3 degrees F. Room sensors shall be recessed wall box mounting and provided with the following:

1. Override pushbutton, which can be programmed in the system to a maximum number of minutes of override.

2. LCD display to indicate sensed values

3. Set points: warmer/cooler adjustment, which can be programmed in the system to a maximum number of +/- degrees of adjustment

4. Temperature sensing

2.7 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.8 ACTUATORS

A. Modulating valves and dampers: provide proportional modulating control capable of positioning the valve or damper at all points across the full range of operation with continuous control action. The sensor, controller and control device (damper, valve, etc.) shall act as one unit to maintain a constant and precise control of the controlled medium. Actuator drives proportional to input signal and modulates throughout its angle of rotation.

B. Two-position valves and damper: provide two-position actuators only where indicated.

C. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Non-spring Return Motors for Valves Larger than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
3. Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
4. Non-spring Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. Size for running and breakaway torque of 150 in. x lbf.

D. Electric Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Provide full modulating damper and valves actuators unless otherwise noted.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: size for required torque calculated as follows:
    a. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring return actuators.
7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

2.9 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Unless otherwise indicated heating system, control valves are to fail in the closed position and chilled water system fails are to fail in the last position.

C. Hydronic system globe valves to have the following characteristics:

1. NPS 2 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back seating capacity repackable under pressure.

2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

3. Sizing: 3-psig maximum pressure drop at design flow rate.

4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

5. Close-off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly valves: 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals. Size at 1 psig max pressure drop at design flow rate.

E. Terminal unit control valves: bronze body, bronze trim, two or here ports, replaceable plus and seats with union and threaded ends.

1. Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.

2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.

3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.10 ELECTROMAGNETIC FLOW METERS

A. Provide an ONICON Model F-3500 Insertion Electromagnetic Flow Meter (or FB-3500 for Bi-directional flow applications), complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to 400 psi. For installations in non-metallic pipe, install grounding rings or probes. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 100:1.

B. Output signals shall be completely isolated and shall consist of the following: (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable, (1) scalable dry contact output for totalization, and (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter. FB-3500 for Bi-directional applications shall provide additional contact outputs for direction and flow totalization in each direction. Each flow meter shall be covered by the manufacturer's two-year warranty.

2.11 DAMPERS

A. Dampers: AMCA-rated, opposed blade design; 0.108-inch minimum thick, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.064-inch thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

B. Edge Seals: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 4 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lb f; when tested according to AMCA 500D.

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATIONS

A. BOILER SYSTEM

1. The boilers and system pumps will be enabled by the BMS when the outside air temperature is below 60 degrees F (adjustable) or manually enabled at the operator workstation.

2. A Boiler Sequence Control System (BSCS) will be provided by the boiler manufacturer. Refer to the Boiler Specification Sections.

3. The BSCS will energize the lead hot water system pump. Modulate the system pump VFD to maintain the required minimum flow rate to each of the operating boilers. The minimum flow rate will vary depending on the number of energized boilers and the minimum flow required by the boiler manufacture. Utilize the electronic flow meter at the pumps to ensure the minimum required flow based on the current number of operating boilers. Coordinate the required minimum flow with the equipment manufacturer to verify the proper flow to each boiler.

4. The BSCS shall control the leaving hot water temperature at each boiler and sequence the boilers as needed to optimize the efficiency of the system.

5. When the system pump is operating at the minimum flow rate required for the boilers and the system pressure is above set point, modulate the differential pressure by-pass valve to maintain system differential pressure.

6. Emergency Burner Control: Provide a complete operational system for emergency burner switches, as required by code, at all exit doors, to interrupt fuel feed to all fuel fired equipment located within the boiler room.

7. Heating System Fill: Provide a water meter to measure record the amount of water used to fill the hot water system.

8. The BMS shall monitor, record and display the following monitoring points on a custom graphic at the operator workstation:
   a. Boiler status: indication and alarm.
   b. Heating supply and return water temperature at each boiler: indication.
   c. Common heating supply and return water temperature: indication.
   d. Heating system water flow in G.P.M: indication and adjustment.
   e. System bypass valve position - indication.
   f. System differential pressure: indication, adjustment and alarm.
   g. Boiler room temperature - indication.
   h. Boiler room temperature set point - indication and adjustment.
   i. Make-up flow (g.p.m.) from the domestic water system: indication.

B. HEAT PUMP LOOP HEAT EXCHANGER

1. The shell and tube heat exchanger shall be controlled by the BMS.

2. The heat pump loop shall operate between the fully adjustable set points of 65 degrees F. (winter) and 92 degrees F. (summer). The existing heat rejection equipment and controls are to remain. Provide temperature sensors in the heat pump loop. When there is a need to add heat to the heat pump loop modulate open the control valve located on the tube side of the heat exchanger. Reverse the sequence when the heat pump loop temperature is satisfied.

3. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:
   a. Control valve position: indication.
   b. Entering and leaving heat pump loop temperatures: indication, adjustment and alarm.

C. HVAC SYSTEM PUMPS

1. The HVAC system heating pumps shall be controlled by the BMS.
2. Provide lead/lag controls for all redundant pumps. In the event the led pump fails, start the lag pump and alarm the system. Provide for a fully adjustable schedule to alternate the led and lag pumps.
3. Provide the required number of sensors in the piping loop to control the pump VFD's and control the system by-pass valve as necessary for the boiler and systems.
4. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:
   a. HVAC Pump status - indication, adjustment and alarm.
   b. Lead/Lag pump status - indication, adjustment and alarm.
   c. System by-pass valve position: indication.
   d. System differential pressure: indication, adjustment and alarm.

D. PACKAGED AIR HANDLING UNIT

1. The units are single zone units with a variable speed supply air fan, hydronic heating coil, filters, and dampers.
2. The unit(s) shall be controlled by the BMS and shall be indexed to the occupied and unoccupied settings at the fully adjustable programmed times.
3. Provide a space thermostat/sensor with adjustable temperature set points. The minimum and maximum space set points shall be set through the BMS.
4. Freeze Protection: Provide a freeze stat, with manual reset, serpentined across the leaving air side of the heating coil and provide programming per the following sequence if the leaving air temperature falls below 35 Degrees F (adjustable):
   a. Signal an alarm on the operator workstation.
   b. Close the outdoor air dampers and open the return air damper.
   c. Fully open the heating coil control valve.
   d. Stop the fan.
5. Provide fully modulating heating control valves that are to fail in the open position. Outdoor air dampers are to fail in the closed position with return dampers failing in the open position. Any relief damper is to fail closed.
6. Provide control wiring between the unit starter and a relay furnished by the electrical contractor to allow for fan(s) shut down when the fire alarm system activates. If activated close all outdoor air dampers.
7. Unoccupied heating cycle:
   a. The outside air damper and any relief dampers will be closed and the return air damper fully open. The supply air fan will be off.
   b. When the space temperature falls below the fully adjustable unoccupied set point temperature of 60 degrees F. start the supply fan at full speed and open the heating coil control valve to provide a 95 degree F. (adjustable) leaving air temperature. When the unoccupied set point temperature has been restored, reverse the above sequence.
8. Occupied heating cycle:
   a. Warm-up: provide optimal start/stop programing through the BMS to index the respective zone to the occupied status and initiate morning warm-up. At this time the unit will operate in the same mode as the unoccupied heating cycle. When the space temperature reaches the fully adjustable occupied set point the unit will operate in the occupied cycle.
   b. During the occupied cycle the supply fan shall run continuously, modulating from low to high speed to maintain the space temperature. Modulate the heating coil control valve in unison with the supply fan VFD, to maintain a leaving air temperature of 95 degrees F. (adjustable) and maintain the space temperature set point.

9. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:
   a. System status: indication and adjustment
   b. Fan status: indication, adjustment and alarm.
   c. Heating coil control valve position: indication and adjustment.
   d. Supply air temperature: indication and adjustment.
   e. Return air temperature: indication.
   f. Smoke detector status: indication and alarm.
   g. Freezestat status: indication and alarm.
   h. Space temperature set point: indication and adjustment.
   i. Space temperature: indication.

E. HYDRONIC DUCT COIL

1. This includes hydronic duct coils installed in existing ductwork that function as pre-heat coils. All pre-heat coils shall also be installed with a freeze pump for freeze protection.

2. The unit(s) shall be controlled by the BMS and shall be indexed to the occupied and unoccupied settings at the fully adjustable programmed times.

3. Provide a leaving air temperature sensor with adjustable temperature set points. The minimum and maximum space set points shall be set through the BMS.

4. Provide fully modulating heating control valves that are to fail in the open position.

5. Freeze Pump: Provide control of the associated freeze pump. All freeze pumps shall energize and operate continuously when outdoor air temperature is below 40 deg. F (adjustable).

6. Freeze Protection: Provide a freeze stat, with manual reset, serpentine across the leaving air side of the heating coil and provide programming per the following sequence if the leaving air temperature falls below 35 Degrees F (adjustable):
   a. Signal an alarm on the operator workstation.
   b. Close the outdoor air dampers and open the return air damper.
   c. Fully open the heating coil control valve.
   d. Stop the fan.

7. Unoccupied heating cycle:
   a. The respective outside air damper and any relief dampers will be closed and the return air damper fully open. The associated supply air fan will be off.

8. Occupied heating cycle:
   a. During the occupied cycle the associated supply fan shall run continuously. Modulate the heating coil control valve to maintain a leaving air temperature of 60 degrees F. (adjustable).

9. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:
   a. System status: indication and adjustment
   b. Fan status: indication, adjustment and alarm.
   c. Heating coil control valve position: indication and adjustment.
   d. Supply air temperature: indication and adjustment.
   e. Freeze pump status: indication and alarm.
   f. Freeze pump setpoint: indication, adjustment and alarm.

F. TERMINAL UNITS

1. All terminal units shall be controlled by the BMS. The respective unit(s) shall be indexed to occupied and unoccupied settings at the programmed times.

2. Provide a space thermostat / sensor with adjustable set points. The minimum and maximum heating set points shall be set at the operator work station.

3. Provide a two-position control valve for all terminal units. Refer to the drawings for the required valve configurations. Valves are to fail in the last position unless the unit has a connection to an outside air duct in which case the valve is to fail open.

4. Hydronic Unit Heater Control: Provide thermostat/sensor to maintain the occupied and unoccupied space temperature by opening the control valve and cycling the fan motor.

5. Cabinet Heater Control: Provide thermostat/sensor to maintain the occupied and unoccupied space temperature by opening the control valve and cycling the fan motor.

6. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:
   a. Status: indication and adjustment.
   b. Room set point: indication and adjustment.
   c. Room temperature: indication and adjustment.

G. EXHAUST FANS

1. Refer to the drawings for notes to indicate fans that are to be controlled by the BMS.

2. Provide controls for exhaust fans noted as "Time of Day Schedule" to allow the fan(s) to operate during the occupied cycle of the respective area. De-energize the fan(s) during the unoccupied cycle.

3. Where fans are noted to have a manual switch, provide an interlock to allow the fan(s) to operate during the occupied cycle of the respective area. De-energize the fan(s) during the unoccupied cycle.

4. Refer to the contract drawings for exhaust fans that are to be operated with an interlock to other equipment. Where so indicated, provide the required interlock and controls. Provide programming to prevent fan operation when the area is in an unoccupied mode.

5. Where noted as "Reverse Acting T'stat", provide a reverse acting thermostat in the space to energize the fan when the space temperature is above the set point. De-energize the fan when the space temperature is below set point. If required, provide motorized dampers as well as the required interlock with the fan and damper(s).

6. Where the drawings indicate a motor operated damper (MOD) is required provide the damper and control of the damper to open when the fan is on and closed when the fan is off.

7. The BMS shall display the following monitoring points on a custom graphic at the operator workstation:
   a. Status for all fans: indication and adjustment.
   b. Occupied and unoccupied scheduling: indication and adjustment.

H. GRAVITY VENTILATORS

1. Where required by the drawings, relief vents are to be provided with motor operated dampers that are to fail closed.

2. Relief vents that are connected to the discharge of an exhaust or relief fan are to be open when the respective fan is in an occupied mode and closed when the system is in an unoccupied mode.

I. MISCELLANEOUS POINTS

1. Miscellaneous Points - The BMS shall display the following monitoring points on a custom graphic at the operator workstation:
   a. Outdoor Air Temperature - indication.
   b. Outdoor Air Humidity - indication.

3.2 INSTALLATION

A. Electrical power:

1. Verify that power supply is available to the operator workstation, all actuators, valves and all other components of the HVAC Control System. Where required, provide low and/or line voltage power from the nearest electrical panel.

2. Unless noted otherwise, line voltage power for system equipment shall be derived from the nearest electrical panel, and shall not be common with other HVAC, plumbing, electrical or architectural equipment. Unless noted otherwise, low voltage power shall be derived from transformers/drivers associated with the system equipment only, and shall not be connected to control power transformers associated with other HVAC equipment (i.e. air handling units, chillers, etc.). System

equipment may share transformers/drivers with other system equipment, provided the transformers/drivers are sized to handle the total load.

3. Control panels for equipment being fed from the emergency generator, including, but not limited to boilers, heating pumps, selected air handling and terminal equipment, etc., power shall be derived from the nearest 120/208 volt normal/emergency panel. Verify equipment that is connected to emergency power with the Electrical Contractor.

4. Install all power and control wiring and cable per the National Electric Code and applicable Division 26 and 27 Sections. Install raceways, boxes, cabinets according to Division 26 and 27 Sections.

5. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

6. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

B. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Connect and configure equipment and software to achieve sequence of operation specified.

D. Verify location of thermostats, humidistats, and other exposed control sensors with drawings and room details before installation. Install devices 48 inches above the floor.

E. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

G. Furnish and install hydronic instrument wells, valves, and other accessories where required.

H. Install refrigerant instrument wells, valves, and other accessories where required.

I. Space sensors:

1. Verify location of thermostats, humidistats, and other control sensors with Drawings and room details before installation. Mount sensors in occupied spaces to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.

2. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.

3. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.

4. In finished areas, recess electrical box within wall.

5. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted.

6. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

J. Flow Meters:

1. Install flow meters is welded and/or copper pipe per manufacturer’s standard installation requirements to allow for removal and reinstallation of the flow meter without the need to drain the system. Provide full port ball valve at connection to pipe.

3.3 QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust all control system components. Report results in writing to the owner's representative.

B. Perform field tests and inspections. Ata minimum perform the following:

1. Operational Test: After electrical circuitry has been energized, start all equipment to confirm proper operation. Remove and replace malfunctioning units and retest.
2. Test and adjust all controls and safeties.
3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
4. Test each point through its full operating range to verify that safety and operating control set points are as required.
5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
6. Test each system for compliance with sequence of operation.
7. Test software and hardware interlocks.

C. DDC System Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. Check dampers. Verify that proper blade alignment, either parallel or opposed, has been provided.
9. Verify that DDC controller power supply is from emergency power supply, if applicable.
10. Verify that wires at control panels are tagged with their service designation and approved tagging system.
11. Verify that spare I/O capacity has been provided.
12. Verify that DDC controllers are protected from power supply surges.

3.4 CALIBRATION AND ADJUSTMENTS

A. Calibrate instruments. Make three-point calibration test for both linearity and accuracy for each analog instrument. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

1. Verify control system inputs and outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
2. Verify flow:

a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.

b. Manually operate flow switches to verify that they make or break contact.

3. Pressure:

a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.

b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

4. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.

b. Calibrate temperature switches to make or break contacts.

5. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

6. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

7. Provide diagnostic and test instruments for calibration and adjustment of system.

8. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

END OF SECTION 23 09 00

SECTION 23 21 10 - HYDRONIC 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 includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the piping systems.

B. Water treatment work will be contracted by the Owner and not part of the work.

1.3 SUBMITTALS

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

1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air control devices.
3. Hydronic specialties.
4. Grooved joint pipe couplings and fitting.
5. Water Treatment provider.

B. Shop Drawings: Detail the piping layout indicating dimensions and elevations of all piping.

C. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. The installation is to conform to the requirements of the 2015 International Mechanical Code and any applicable local codes. Verify local code requirements with the Authority Having Jurisdiction.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

D. All grooved joint couplings, fittings, valves and other specialties shall be provided from a single manufacturer. Grooving tools shall be from the same manufacturer as the grooved components. All castings used for coupling housings, valve bodies, fittings, etc. shall be date stamped for traceability and quality control.

E. Pressure seal piping systems: Installer shall be a qualified installer, licensed within the jurisdiction, and familiar with the installation of the copper press joint system. The copper press fittings shall be installed using the proper tool, actuator, jaws and rings as instructed by the press fitting manufacturer. The installation of copper tubing in Hydronic systems shall conform to the requirements of the ICC International Mechanical Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 125 psig at 200 deg. F.
2. Blowdown-Drain Piping: 200 deg. F.
3. Air-Vent Piping: 200 deg. F.
4. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings and Unions: ASME B16.22.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Piping Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by Victaulic Company of America or Anvil International.
2. Steel Pipe: ASTM A 53, carbon steel, schedule 40, roll or cut grooved ends.
3. Fittings: ASTM A 395, grade 65-45-12 ductile iron; ASTM A 536, grade 65-45-12 wrought steel conforming to ASTM A-235/A 53M, Type F, E, or S, Grade B factory fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, to secure grooved pipe and fittings.
4. Couplings: Ductile iron conforming to ASTM A-536, Grade 65-45-12.
   a. NPS 2 through NPS 8; rigid coupling with high temperature range (-30 degrees F to 250 degrees F; Grade EP EPDM gasket.
   b. NPS 10 through NPS 12; rigid coupling with Grade EP EPDM gasket (-30 degrees F to 230 degrees F)..
   c. NPS 2 through NPS 12: flexible coupling for use in locations where vibration attenuation and stress relief is required. Three flexible couplings may be used in lieu of a flexible connector.

I. Mechanical-Joint Piping Systems:

1. Manufacturers: Victaulic Company of America, Quick-Vic Systems.
2. Steel Pipe: ASTM A 53, schedule 40.
3. Couplings and Fittings: ASTM A 536, grade 65-45-12.
4. Gaskets: Grade EHP EPDM (-30 degrees F to +250 degrees F).

2.4 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. 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.

E. Grooved Joint Lubricants: lubricate gaskets using a lubricant supplied by the coupling manufacturer. Lubricant shall be suitable for the gasket elastomer and fluid media.

1. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 EXPANSION FITTINGS AND COMPENSATORS

A. Grooved Mechanical-Joint Piping Systems:

1. Victaulic Style 150 Mover slip type expansion joint with 3” axial movement. Designed for service temperature to 230 degrees F and a working pressure of 350 psi maximum. Provide Grade “E” EPDM gaskets.
2. Victaulic Flexible Loop Series 159 with 4’ axial movement: Designed for service temperatures to 350 degrees F. maximum and working pressure of 150 psi. Schedule 40 carbon steel end connections and 321 stainless steel corrugated hose.

B. Welded or Soldered Joint Piping Systems: Provide in-line expansion compensators manufactured by Hyspan Precision Products or Metraflex Inc. Compensators to be rated for a maximum pressure of 175 psi and 230 degrees F. operating temperature.

2.6 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

D. Dielectric Couplings:

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

a. Calpico, Inc.
b. Lochinvar Corporation.

2. Galvanized-steel coupling with inert and non-corrosive thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg. F.

E. Dielectric Nipples:

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

a. Perfection Corporation; a subsidiary of American Meter Company.
b. Victaulic Company of America.

2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg. F.

2.7 VALVES AND SPECIALTIES

A. Calibrated Balancing Valves:

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

a. IMI Flow Design Inc. Model UA
b. NuTech Model MB/MBF/MBG

2. Valves ½" to 2": to have venturi type bronze body, chrome plated ball, EPDM seals. Provide pressure & temperature test ports across valve measurement area. Ports to be fitted with dual durometer EPDM cores, brass cap & O-ring seal. Valves to have drain/purge port. Provide valve

with memory stop , memory lock & calibrated position indicator. Valves to be rated at 200 PSIG at 2500 F and be 100% positive shut-off. Measurement accuracy to be +/- 3%.

3. Valves 2-1/2" & Larger: to have venturi type cast carbon steel/ductile iron body, with SS steam, EPDM seat & Buna seals. Provide memory stop, memory lock & calibrated position indicator. Valves to be rated at 200 PSIG at 2250 F and be 100% positive shut-off. Measurement accuracy to be +/- 3%.

B. Flow Meters:

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

   a. Bell & Gossett Domestic Pump; a division of ITT Industries or equal.

2. Description: Differential-pressure-design wafer type orifice insert for installation between pipe flanges; with calibrated flow-measuring element, separate flowmeter, hoses or tubing, valves, fittings, and conversion chart compatible with flow-measuring element, flowmeter, and system fluid. Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
3. Construction: Cast-iron body, brass valves with integral EPT check valves and caps, and calibrated nameplate.
4. Temperature/Pressure Rating: 250 degrees F. at 250 psig.

C. System Fill Pressure-Reducing Valves:

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

   a. Amtrol, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Bronze body construction with NPT threaded inlet and outlet connections, a tight seating check valve, purge lever for manual purging, and built-in integral strainer. High capacity performance suitable for use in hydronic heating and cooling systems. Maximum Pressure: 100psi.

D. Safety Relief Valves (Diaphragm-Operated):

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

   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Body: for NPT ¾" and 1", Bronze with 125 PSIG maximum working pressure and 250 degree F. maximum operating temperature.
3. Body: for NPT 1 ½" and 2", Cast Iron with 50 PSIG maximum working pressure and 250 degree F. maximum operating temperature.
4. Diaphragm and Seat: EPDM.
5. Wetted, Internal Work Parts: Brass.
6. Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Water Meters:

1. Manufacturers: Subject to compliance with requirements provide water meters manufactured by Neptune Technology Group or equal.
2. All meters to be displacement type - magnetic drive 5/8" - 2" and shall be produced from an ISO 9001 manufacturing facility and conform to the "Standard Specifications for Cold Water Meters" C700, latest revision issued by AWWA or as otherwise stated. Only magnetic-driven, positive displacement meters of the flat disc type will be accepted because of enhanced low flow accuracy performance.
3. The size, capacity, and meter lengths shall be as specified in AWWA Standard C700 (latest revision). The maximum number of disc nutations is not to exceed those specified in AWWA C700 latest revision. All meter maincases shall be made of a no-lead high copper alloy containing a minimum of 85% copper that meets the ANSI/NSF 61 standard. The serial number should be stamped between the outlet port of the maincase and the register. Maincase markings shall be cast raised and shall indicate size, model, direction of flow, and NSF 61 certification. Plastic maincases are not acceptable. Maincases for 5/8", 3/4" and 1" meters shall be of the removable bottom cap type with the bottom cap secured by four (4) bolts on 5/8" and 3/4" sizes and six (6) bolts on the 1" size. Intermediate meter maincases shall also be made of the same lead-free brass material in sizes 1-1/2" and 2" with a cover secured to the maincase with eight (8) bolts. Meters with a frost plug, a screw-on design or no bottom cap shall not be accepted in 5/8"-1" sizes. The 5/8" meters shall have a synthetic polymer or cast iron bottom cap option. All no-lead maincases shall be guaranteed free from manufacturing defects in workmanship and material for the life of the meter. All meters must be adaptable to a field programmable absolute encoder register without interruption of the customer's service.
4. Direct Read Standard Register: The register shall be of the straight reading sealed magnetic drive type and shall contain six (6) numeral wheels. Registers must be roll sealed and dry. All direct reading register cups shall be copper to prevent corrosion and be covered with a high strength, impact resistant flat glass lens to prevent breakage. The lens shall be positioned above the register box to allow for run off of debris. The register lid shall overlap the register box to protect the lens. Register boxes and lids shall be of high-strength synthetic polymer or approved equivalent. All registers shall have the size, model and date of manufacture stamped on the dial face. The dial shall have a red center sweep hand and shall contain 100 equally divided graduations at its periphery. The register must contain a low flow indicator with a 1:1 ratio to disc nutations to provide leak detection. Registers shall be secured to the main case by means of a plastic tamper-proof seal to allow for inline service replacement. Register seal screws are only accepted when supplied with attached sealing wire to at least one bottom cap bolt with seal wire holes of not less than 3/32" in diameter.
5. Strainers: All meters shall contain a removable polypropylene plastic strainer screen. The strainer shall be located near the main case inlet port, before the measuring chamber. The strainer shall also function as the device that holds the measuring chamber in place within the main case.

F. Reduced-Pressure-Principle Backflow Preventers: Drawing Tag "RPB"

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. Watts Industries, Inc.; Water Products Div.
   d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
5. Temperature range: 210 degrees F.
6. Size: as indicated on the drawings.
7. Pressure Loss and Design Flow Rate: as indicated on the drawings.
8. Body: Lead free bronze construction for NPS 2 and smaller; epoxy coated cast iron complying with AWWA C550 and FDA approved for NPS 2-1/2 and larger.

9. Accessories: Ball type valves on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger. Provide strainers on the inlet. Provide Air-Gap Fitting, ASME A112.1.2, matching backflow-preventer connection.

G. Backflow Preventers: Drawing Tag “BP”

1. Provide a Series 9D Dual Check Backflow Preventer manufactured by Watts Industries or equal as manufactured by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1012.
3. Temperature range: 33^0 F to 250^0 F.
4. Size: as indicated on the drawings.
5. Working Pressure: 25 to 175 psi.
6. Body: forged brass.

2.8 AIR CONTROL DEVICES

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

1. Amtrol, Inc.
2. Bell & Gossett Domestic Pump; a division of ITT Industries.
3. Taco.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. CWP Rating: 150 psig (1035 kPa).
4. Maximum Operating Temperature: 225 deg. F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg. F.

D. Expansion Tanks/Diaphragm Bladder-:

1. Tank: Welded steel, rated for 125-psig working pressure and 240 deg. F. maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Diaphragm/Bladder: Heavy duty Butyl Rubber, securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

E. Centrifugal Type Air Separators:

1. The air separator must be designed, constructed and stamped for 125 psig @ 350ºF in accordance with Section VII, Division I of the ASME Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inspectors. The air separator(s) shall be painted with one shop coat of light gray air dry enamel.
2. The unit shall have flanged inlet and outlet connections tangential to the vessel shell. The unit shall have the capability to direct accumulated air to the compression tank (air control system) or air vent (air elimination system) via an NPT vent connection at top of unit. A blowdown connection shall be provided to facilitate routine cleaning.

F. In-Line Air Separators:

1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig.
3. Maximum Operating Temperature: Up to 300 deg. F.

G. Air Purgers:

1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig.
3. Maximum Operating Temperature: 250 deg. F.

2.9 CHEMICAL TREATMENT AND EQUIPMENT

A. Bypass Chemical Filter Feeder: Provide bypass filter/feeders where shown on the drawings, manufactured by Neptune Chemical Pump Company or equal. The bypass feeder shell shall be constructed of 11 gauge steel minimum for 2 gallon units and 10 gauge steel minimum for 5 gallon and larger units. Tank heads shall be a minimum of 11 gauge steel for 2 gallon units and a minimum 9 gauge steel for 5 gallon units. The bypass feeder shall be rated at 300 psi and to 200 degrees F. The tank shall have a wide mouth, 3-1/2” opening so that chemical addition can be performed without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring 2-1/2 turns to close and seal. Closures using partial threads or lugs shall not be considered. Closures rated less than 300 psi shall not be considered equal. The cap shall be constructed of cast iron with an epoxy-coated underside to prevent corrosion and shall use a square ring gasket seal. The ring gasket shall not be glued or restrained from movement. Closures using “o” rings or gaskets which are glued or restrained from free movement by snap rings shall not be considered equal. The bypass feeder shall be provided with legs to elevate the feeder off the floor. The legs shall have holes to allow mounting by anchor bolts. The bypass feeder shall be provided with a 5 micron cartridge filter for simultaneous side stream filtering.

B. Chemicals: Provide specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

2.10 HYDRONIC PIPING SPECIALTIES

A. Suction Diffusers:

1. Angle pattern flow straightening fitting equipped with a combination diffuser strainer- orifice cylinder, flow straightening vanes, start-up strainer and filed supplied adjustable support foot. The combination diffuser-strainer-orifice cylinder shall be designed to withstand pressure differential equal to the system pump shutoff head and shall have a free area equal to five times the cross section area of the pump suction opening. The length of the flow straightening vanes shall be no less than 21/2 times the diameter of the system pump suction connection.
2. Provide cast iron NPT and flanged models rated for a maximum working pressure of 175 PSIG. The flow straightening fitting shall be of cast iron construction with Stainless steel combination diffuser-strainer-orifice cylinder with 3/16" diameter perforations to protect the system pump. Provide start-up strainer of 16 mesh bronze. All internal components shall be replaceable.

B. Y-Pattern Strainers: Subject to compliance with requirements, provide products by Metraflex, Hoffman Specialty, Armstrong or equal:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded or sweat for NPS 2 and smaller: grooved or flanged for NPS 2-1/2 and larger.
3. Strainer Screen: perforated stainless steel with 50 percent total free area.
4. CWP Rating: 150 psig.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg. F.
6. Three Victaulic Style 77 couplings may be used in lieu of a flexible for vibration attenuation and stress relief at equipment connections. The couplings shall be in close proximity to the vibration source.

D. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg. F.

2.11 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides: Where required provide alignment guides manufactured by Metraflex Inc or equal. Guides to be factory-fabricated alignment guides suitable for installation with insulated piping where applicable.

B. Anchors: Provide factory fabricated anchors manufactured by Metraflex or equal. In lieu of factory fabricated anchors provide field fabricated anchors fabricated from ASTM A36 / A36M steel shapes and plates.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating, aboveground, NPS 2 and smaller, shall be one of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
3. Pressure seal piping systems.
4. Victaulic Quick-Vic systems.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
   a. Provide high temperature couplings at all connections to boilers and heat exchangers and on all heating system piping located within the boiler room.
   b. Provide flexible couplings at connections to all pumps. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

C. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

D. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 VALVE APPLICATIONS

A. Install shut off-duty valves at each branch connection to supply mains, and at supply and return connection to each piece of terminal equipment and at other locations indicated on the drawings. All valves are to be installed in an accessible location.

B. Install calibrated balancing valves in the return pipe of each heating or cooling terminal and elsewhere as shown on the drawings. Valves are to be installed with the test ports facing 40 degrees to vertical above the centerline of the pipe.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Where indicated, install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

F. Isolation valves for each boiler are to be labeled with warnings required by the PA Department of Labor and Industry. Verify requirement before installation begins.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general routing, location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings. Provide offsets where required to clear steel, electrical conduit and / or other construction components.

B. Install cast-iron sleeve with water stop and provide Mechanical Sleeve Seal where HVAC piping penetrates a foundation wall or exterior. Select number of interlocking rubber links required to make installation watertight.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install fittings for changes in direction and branch connections. Install piping to allow application of insulation.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

K. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

N. Install unions in piping**,** NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated. Unions and flanges are not required in grooved system installations as the couplings serve as disconnection points.

O. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple, ball valve and hose connection in blowdown connection of strainers. Match size of strainer blow-off connection for strainers smaller than NPS 2.

P. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

Q. Provide Firestopping at all rated partitions. Provide a caulked and sealed installation at all non-rated partitions.

R. Provide expansion compensator joints or expansion loops for cooper, steel and / or PEX –a piping where indicated on the drawings. Provide the quantity of pipe anchors and alignment guides as required by the expansion compensator manufacturer. Provide shut-off valves at the inlet and outlet of the expansion compensators and/or expansion loops. Install expansion joints, guides and anchors per the manufacturer's installation requirements. Install anchors at locations indicated and per the following:

1. To Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

   To Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.

3.4 HANGERS AND SUPPORTSs

A. Support all HVAC system piping to conform to ASME B31.9. Provide adjustable clevis hangers for all horizontal piping. Each hanger shall allow for adjustment, after installation, while supporting the pipe. Attach hangers to structural steel in accordance with MSS SP-69 and MSS SP-89. Install piping hangers and supports to provide the indicated pipe slopes.

B. Provide miscellaneous structural steel for support of HVAC equipment and piping. In areas with exposed construction, install miscellaneous supports prior to painting of ceiling and walls.

C. Provide a 12" long 18 gage protective saddle for all clevis hangers that support insulated piping.

D. Use carbon-steel pipe hangers and supports and attachments for general service applications.

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

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

G. Install hangers for steel piping with the following maximum spacing:

1. NPS 3/4 to NPS 2: 8 feet maximum horizontal spacing.
2. NPS 2 and larger: 12 feet maximum horizontal spacing.
3. Vertical supports at roof, at each floor, and at 10 foot maximum intervals.

H. Install hangers for drawn-temper copper tubing with the following maximum spacing: a

1. NPS 1-1/4 and smaller: 6 feet maximum horizontal spacing.
2. NPS 1-1/2 and larger: 10 feet maximum horizontal spacing.
3. Vertical supports at roof, at each floor, and at 10-foot maximum intervals.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
4. 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:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

    b. 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.

B. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

C. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

D. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts in accordance with the manufacturer’s written instructions. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings of the same manufacturer.

1. The grooved couplings factory trained representative shall provide on-site training for the contractor’s field personnel in the use of grooving tools and the installation of grooved joints.
2. The representative shall visit the job site periodically to review the installation and verify the system is being installed per the manufacturer’s recommendations.
3. A direct employee of the grooved piping system manufacturer must conduct the training and site visits. A distributor representative is not acceptable.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at all high points in all piping systems, at heat-transfer coils, where required for system air venting and at locations indicated on the drawings.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Where indicated install air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Where indicated, install tangential air separator in pump suction piping.

F. Install bypass chemical filter/feeders in each hydronic system where indicated, in upright position with top of unit more than 48 inches above the floor. Install feeder with bypass line, full-size ball valve and balancing valve. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a ball valve. Verify installation details with the manufacturer to verify inlet and outlet connection locations.

G. Install expansion tanks on the floor or properly suspended from the structure. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system project requirements. Provide ASME relief valves and pressure gauges on all expansion tanks per PA Labor and Industry requirements. Connect piping from the system to the expansion tank and the side of the pipe main, not the top or bottom of the main.

H. BACKFLOW PREVENTERS:

1. Install Reduced-Pressure-Principal-Backflow-Preventers (noted as RPB on the drawings) in each water supply to HVAC equipment and systems.

2. In addition to installing the RPB, install Backflow Preventers (noted as BP on the drawings) in each water fill connection for boiler fill systems.

3. Install drain for all backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

4. Do not install bypass piping around backflow preventers. Locate backflow preventers in same room as connected equipment or system. Do not install bypass piping around backflow preventers.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections. Install control valves in accessible locations close to connected equipment.

B. Provide shut-off valves on the supply and return connections to all terminal equipment. Where indicated, install bypass piping with ball or butterfly valve around control valve.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

D. Connections to any control valve, shut-off valve, strainer, balancing devices or other similar devices with bronze construction shall be made with an adapter fitting and/or nipple made of the same material.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace all strainer screens. If the project has multiple construction phases provide the necessary labor and materials for flushing and cleaning of the hydronic system for each phase.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 23 21 10

SECTION 232130 - HYDRONIC PUMPS

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 in-line centrifugal pumps, base mounted pumps and accessories.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of concrete bases.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

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

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Bell & Gossett; Div. of ITT Industries.
4. Patterson Pumps.
5. Taco, Inc.

B. Description: Factory assembled and tested, centrifugal, close-coupled, in-line pump designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175-psig (1204-kPa) working pressure and a continuous water temperature of 225 deg F (107 deg C). Each pump shall be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

C. Pump Construction: Pump volute shall be Class 30 cast iron and shall be hydrostatically tested to 150% maximum working pressure. The casing shall be radially split to allow removal of the rotating element without disturbing the pipe connections. The impeller shall be ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance. The liquid cavity shall be sealed off at the motor shaft by an internal mechanical seal with ceramic seal seat and carbon seal ring, suitable for continuous operation at 225 degrees F.

D. Motors to meet NEMA specifications and shall be the size and voltage as indicated on the drawings. The motor shall have heavy duty grease lubricated bearings designed for the maximum load required by the motor.

2.3 BASE MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

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

1. Armstrong Pumps Inc.
2. Aurora Pump; Division of Pentair Pump Group.
3. Bell & Gossett; Div. of ITT Industries.
4. Patterson Pumps.
5. Taco, Inc.

B. Description: Factory-assembled and tested, centrifugal, end-suction pump designed for installation with pump and motor shafts mounted horizontally. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F (107 deg C). Each pump shall be thoroughly cleaned and painted with at least one coat of high grade machinery enamel prior to shipment.

C. Pump Construction: Pump volute shall be made of ductile iron with integrally cast pedestal support. The impeller shall be cast bronze, enclosed type, statically and hydraulically balanced. Impeller shall be keyed to the shaft and secured by a hex head impeller nut and washer. Pumps shall be provided with a single inside unbalanced mechanical shaft seal for leakless operation. A suitable arrangement shall be provided to furnish a portion of the pumped liquid to lubricate and cool the seal faces. Casings shall be provided with tapped and plugged holes for priming, vent, and drain. Pump bearing housing shall have heavy-duty greasable ball bearings. The base shall be made of structural steel and shall also include an integral drain pan. A flexible coupler suitable for both across the line starting applications as well as variable torque loads associated with variable frequency drives, shall connect the pump to the motor and shall be covered by a coupler guard.

D. Motors: The motor shall be NEMA specifications and shall be the size and voltage called for on the drawings. Pump and motor shall be factory aligned, and shall be realigned by contractor after installation. Provide shaft grounding rings on all motors controlled by variable frequency drives.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Cast Iron NPT and Flanged Models Rated for a Maximum Working Pressure of 175 PSIG. The flow straightening fitting shall be of cast iron construction. The fitting shall have a Stainless steel combination diffuser-strainer-orifice cylinder with 3/16" diameter perforations to protect the system pump. The full length Stainless steel flow straightening vanes shall provide non-turbulent flow to the suction side of the system pump. The start-up strainer shall be of 16 mesh bronze, and the support foot shall eliminate pipe strain at the flow fitting/pump connection. All internal components shall be replaceable.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

3.2 PUMP INSTALLATION

A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

C. Install continuous-thread hanger rods and of sufficient size to support pump weight.

D. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and vibration isolators of sufficient size to support pump weight.

E. Set base-mounted pumps on concrete pad.

3.3 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment.

3.4 CONNECTIONS

A. Install piping adjacent to pumps to allow service and maintenance clearance.

B. Connect piping to pumps providing all required fittings. Install valves and other accessories that are same size as piping connected to pumps.

C. Install check valve and throttling valve or triple-duty valve on discharge side of pumps.

D. Install Y-type strainer or suction diffuser on suction side of all pumps. Install a shutoff valve on suction side of pumps.

E. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

F. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 30

SECTION 23 31 10 - 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 metal ducts and accessories for various types of air distribution systems.

1.3 PERFORMANCE REQUIREMENTS

A. 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 as indicated in Part 3 of this specification.

B. Refer to the contract drawings for any notes that indicate requirements for duct construction that may differ from the SMACNA standard requirements. Where indicated provide duct construction that meets requirements.

1.4 QUALITY ASSUANCE

A. Comply with the requirements of NFPA 90A and 90B.

B. The installation of all ductwork shall comply with the requirements of the 2015 International Mechanical Code and all applicable local codes and code amendments.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect all ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent dirt and moisture from entering ducts and duct fittings. Store ductwork in an area which is protected from the weather. All ductwork shall be shipped with a protective polyethylene film or other water tight covering at the ends of all ducts and fittings. While ducts are stored on-site the protective covering shall remain in place.

PART 2 - PRODUCTS

2.1 SINGLE WALL RECTANGULAR DUCTS AND FITTINGS

A. Refer to and comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Rectangular Duct Construction," for fabrication of ducts based on the static-pressure class indicated in Part 3 of this specification.

B. Fabricate ducts with a gage thickness per the requirements of Chapter 2.

C. Longitudinal Seam, Traverse Joints and Reinforcements: Select and fabricate seam, joint, reinforcement types and sealing requirements and according to the requirements in Chapter 2 for required static-pressure class, applicable sealing requirements, duct-support intervals, and other provisions in the SMACNA Standard."

D. Duct fittings: fabricate elbows, turning vanes, branch connecters, offsets and transitions in accordance with Chapter 4 of the SMACNA "HVAC Duct Construction Standards - Metal and Flexible."

1. Radius elbows: type RE 1 with a center line radius equal to 1.5 times the duct width.
2. Square throat elbows: type RE 2 with turning vanes per figure 4-3 and 4.4.
3. Branch connections: 45 degree entry.

2.2 SINGLE WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Fabricate ducts with a gage thickness per the requirements of Chapter 3.

C. Longitudinal Seam, Traverse Joints and Reinforcements: Select seam, joint, reinforcement types and sealing requirements and fabricate according to the requirements in Chapter 3 for required static-pressure class, applicable sealing requirements, duct-support intervals, and other provisions in the SMACNA Standard."

D. Duct fittings: fabricate elbows and tees in accordance with Chapter 3.

1. Elbows: fabricate with a center line radius equal to 1.5 times the duct diameter.
2. Tees and laterals: fabricate per figure 3-5

2.3 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: G60 for interior ductwork conveying non-hazardous materials; G90 for interior ductwork conveying hazardous materials; G90 for exterior ducts without exterior insulation.
2. Finishes for Surfaces Exposed to View: Mill phosphatized and suitable for painting.

2.4 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. 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 (2500 Pa), 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.

2.5 HANGERS AND SUPPORTS

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

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

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

D. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Fabricate, install and support ductwork and accessories according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

B. The installing contractor is required to field verify all duct locations and elevations prior to fabrication of the ductwork.

C. 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.

D. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures. Do not locate ducts over electrical panels.

E. Install ducts with fewest possible joints. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

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

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

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

I. Where ducts pass through non-fire-rated interior masonry or drywall partitions and any type of exterior wall(s), 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. Paint interiors of metal ducts that do not have duct liner for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer.

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."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports and the requirements of the International Mechanical Code Section 603. Support spacing of all hangers shall be per SMACNA standards but in no case shall hangers be spaced at more than 10’-0” intervals.

B. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Rectangular Duct Hangers Minimum Size," and "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.

C. 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 12 feet.

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

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

E. 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.

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 DUCT SCHEDULE

A. Fabricate ducts with G90 galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:

1. Ducts Connected to the discharge of packaged Air Handling Units:

a. Pressure class: positive 1-inch wg.

b. Minimum SMACNA seal class: B.

C. Return Ducts:

1. Pressure Class: Positive or negative 2-inch wg.
   a. Interior ducts: minimum SMACNA seal class B.
   b. Exterior ducts: minimum SMACNA seal class B.

D. Exhaust Ducts:

1. Pressure Class: Positive or negative 1-inch wg.
   a. Minimum SMACNA seal class: B if negative pressure, and B if positive pressure.

E. Outdoor-Air:

1. Pressure Class: positive or negative 1-inch wg.
   a. Minimum SMACNA Seal Class: B.

END OF SECTION 23 31 10

SECTION 23 34 00 - EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes various types of exhaust fans and accessories. Refer to the drawings plans and schedules and provide all required options and accessories.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and 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 gages and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.

B. 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. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For power ventilators to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all similar types of fans from one source and from a single manufacturer, regularly engaged in production of exhaust fans.

B. 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.

C. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. UL Standard: Power ventilators shall comply with UL 705.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 COORDINATION

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

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.7 WARRANTY

A. All equipment, material and labor provided under this specification section shall be warranted for a period of one year from the date of substantial completion.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL DOWNBLAST ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide roof ventilators manufactured by Loren Cook models ACE-B and / or ACE-D. Subject to review, equipment meeting the full requirements of the specifications, manufactured by the following will be considered:

1. Carnes Corp.
2. Greenheck.
3. Penn Barry.
4. Solar & Palau, USA.
5. CaptiveAire

B. Description: Belt-driven or direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle with square aluminum base and venturi cone inlet for exhaust applications; and die formed louvered aluminum inlet panels in rectangular configuration with square base and rectangular outlet for makeup applications.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from airstream on exhaust fans.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent on direct drive units.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, ½-inch mesh, aluminum or brass wire.

2.2 ROOF CURBS

A. Provide insulated metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

B. Refer to drawings for the type of curb required for the specified roofing system and the required curb height. Provide curbs with an integral metal cant, stepped integral metal cant raised the thickness of roof insulation or as required to suit the details.

C. Provide curbs to match the roof slope. Refer to contract drawings to verify roof slope.

D. Curb Material: Galvanized sheet, 0.090 inch thick

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware.

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

D. Install units with clearances for service and maintenance.

E. Roof curbs: furnish and install a roof curb for all roof mounted fans. Install the roof mounted unit(s) on the roof curb immediately after the curb is installed. If immediate installation is not performed provide temporary watertight covering, for all curb openings, consisting of minimum ¾" exterior grade plywood and watertight rubber or plastic cover.

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.

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

C. Ground equipment.

3.3 FIELD QUALITY CONTROL

A. Equipment Startup Checks: Perform startup per Manufacturer's Instructions on all fans. Verify that unit is secure on mountings and supporting devices and connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

B. Verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.

C. Verify lubrication for bearings and other moving parts.

D. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

E. Starting Procedures: Energize motor and adjust fan to indicated rpm and measure and record motor voltage and amperage.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.

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

H. Shut unit down and reconnect automatic temperature-control operators.

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

J. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

K. The installing contractor shall provide a completed written startup report that records results of all tests and inspections and verifies all fans, associated controls and wiring are installed properly. The start-up report shall be forwarded to the owner’s representative.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation and adjust belt tension where required..

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 23 34 00

SECTION 23 37 20 - GRAVITY 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. This Section includes roof mounted intakes (OAI) and relief vents (RV). Refer to drawing schedules for type(s) of Gravity Ventilators required.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Intake and relief ventilators shall be capable of withstanding the effects of gravity loads, wind loads and thermal movements without permanent deformation of components, noise or metal fatigue, or permanent damage to fasteners and anchors.

1.4 SUBMITTALS

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

B. Shop Drawings: Include details on ventilator size, performance data, and roof curb details.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain ventilators through one source from a single manufacturer regularly engaged in the manufacture of gravity ventilators.

B. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1.6 COORDINATION

A. Coordinate installation of roof curbs and roof penetrations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Fasteners: Same basic metal and alloy as fastened metal. Do not use metals that are incompatible with joined materials.

2.2 GENERAL FABRICATION

A. Fabricated intake and relief ventilators to minimize field splicing and assembly. When required, disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

2.3 GRAVITY VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide gravity intake and / or exhaust roof ventilators manufactured by Loren Cook model GR and/or GI. Subject to review, equipment meeting the full requirements of the specifications, manufactured by the following will be considered:

1. Carnes.
2. Greenheck.
3. Penn-Barry

B. The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The hood shall be constructed of minimum 18 gauge aluminum, bolted to a minimum 8 gauge aluminum support structure. A radius throat must be provided for optimum performance. Lifting lugs shall be provided to help prevent damage from improper lifting. The base shall have continuously welded curb cap corners for maximum leak protection. Birdscreen constructed of 1/2" galvanized mesh shall be mounted in the hood. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM and static pressure.

2.4 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, with galvanized-steel sheet.

B. Bird Screening: Galvanized-steel, 1/2-inch square mesh, 0.041-inch wire.

C. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

2.5 ROOF CURBS

A. Provide insulated metal roof curbs, internally reinforced and capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Fabricate with welded or sealed mechanical corner joints, with integral formed mounting flange at perimeter bottom. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

B. Refer to drawings for the type of curb required for the specified roofing system and the required curb height. Provide curbs with an integral metal cant, stepped integral metal cant raised the thickness of roof insulation or as required to suit the details.

C. Provide curbs to match the roof slope. Refer to contract drawings to verify roof slope.

D. Curb Material: Galvanized sheet, 0.090 inch thick

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install intake and relief ventilators level, plumb.

B. Secure intake and relief ventilators to roof curbs with cadmium-plated hardware. Use concealed anchorages where possible.

C. Install goosenecks on curb base.

D. Install intake and relief ventilators with clearances for service and maintenance.

E. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

G. Install motor operated and / or backdraft dampers where indicated.

H. Roof curbs: furnish and install a roof curb for all roof mounted vent. Install the roof mounted unit(s) on the roof curb immediately after the curb is installed. If immediate installation is not performed provide temporary watertight covering, for all curb openings, consisting of minimum ¾" exterior grade plywood and watertight rubber or plastic cover.

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.

3.3 ADJUSTING

A. Where applicable, adjust damper linkages for proper damper operation.

END OF SECTION 23 37 20

SECTION 23 52 88 – WATER TUBE CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and assembled, high efficiency gas-fired, water-tube condensing boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS

A. The installing contractor is required to submit the applicable PA L and I forms prior to boiler installation. See Part 3.

B. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

C. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: Power, signal, and control wiring.

D. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

F. Startup service reports.

1.4 RFEERANCES

A. American Society of Mechanical Engineers:

1. ASME Section IV: Boiler and Pressure Vessel Code - Heating Boilers

2. ASME CSD-1: Controls and Safety Devices for Automatically Fired Boilers.

B. American Society of Heating, Refrigeration and Air Conditioning Engineers:

1. ASHRAE: Standard 90.1 Energy Standard for Buildings

C. National Fire Protection Association:

1. NFPA 54: National Fuel Gas Code (ANSI Z223.1).

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.6 DELIVERY STORAGE AND HANDLING

A. Boilers and accessories are to be shipped factory packaging. Inspect for damage. Keep boiler in a vertical position from time of delivery to final installation.

B. While stored, all equipment must be protected from external elements such as inclement weather, job site construction activity, etc. Protect equipment from damage by leaving packaging in place until installation.

1.7 BOILER WARRANTY

A. The boiler shall come with the warranties stated below. Warranty period shall be one (1) year from date of start-up or eighteen (18) months from date of shipment, whichever comes first.

1. Heat exchanger: provide a 10-year pro-rated warranty.

2. All other parts shall carry a 1-year limited warranty.

1.8 VENTING WARRANTY

A. Provide manufacturer's warranty in which the 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. The warranty period shall be 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements provide boilers manufactured by Bryan Boilers.

2.2 BOILER PERFORMANCE

A. Boiler thermal efficiency shall be no less than 97.0%.

B. The burner shall emit low NOx (corrected to 3% O2) emissions at all firing rates.

C. Provide services of a manufacturer's authorized representative to perform combustion test including boiler firing rate, gas flow rate, heat input, burner manifold gas pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, mid-range, and high fire.

2.3 GENERAL REQUIREMENTS

A. Boiler shall be capable of variable primary or primary/secondary piping arrangements.

B. The boiler shall be assembled, fire-tested and shipped as a factory-packaged unit, complete with jacket, gas manifold, burner and controls mounted & wired, with boiler connections specified in this section.

C. The boiler shall be constructed in conformance to ASME Section IV, ASME CSD-1 and UL 795. The boiler shall bear the ASME “H” with a maximum allowable working pressure of 160 PSI. The pressure vessel shall be subjected to a hydrostatic pressure test of 240 PSIG at the factory

D. The boiler shall be an ultra-high efficiency condensing boiler with a pressure vessel, constructed of 316L stainless steel and of water tube design, which shall not require a refractory combustion chamber.

E. The boiler shall be equipped with an integral pre-mix, stainless steel forced draft burner incorporating full modulation with 5:1 turndown. The burner shall be of high flame retention design and have a static swirl

device to get uniform flame stability all around the combustion surface. Burner shall be equipped with a sliding guide rail with hinged door to gain full access and inspection of the burner and combustion chamber.

F. The boiler gas valve will be designed with zero pressure regulation and equipped with a variable speed blower system to precisely control the fuel/air mixture, providing fully modulating firing rates for maximum efficiency.

G. Water connections shall be located at the top of the boiler; flue gas exhaust, combustion air intake and condensate drain connections shall be located in the rear of the boiler and incoming gas connection shall be located on the left side of the boiler. A factory supplied oversized ASME relief valve shall be provided with the boiler(s).

H. The flue passages and combustion chamber shall be accessible from the front of the boiler for cleaning.

I. The boiler shall be provided with a heavy duty 16 gauge steel jacket with a rust resistant powder coat finish. The boiler jacket shall contain an internal electrical cabinet for power and limit circuit wiring, providing a clean finished look when the jacket is installed. Electrical connections shall be accessible from top and/or left-side of the boiler on five (5) printed circuited boards (120VAC high and 24VAC/5VDC low voltage) with fused connections for protection and clear labeling for simple and accurate wiring. The electrical components shall be separated from incoming combustion air gas, which may contain excess humidity, dust and other contaminants brought through ducted combustion air.

J. A polypropylene condensate trap with a float-actuated shut-off switch shall be supplied with the boiler.

2.4 BOILER TRIM

A. Provide the following trim:

1. 3.5” dia. Combination temperature pressure gauge.
2. Supply and return temperature sensors shall be mounted on the supply and return connections outside of the boiler jacket. Each sensor shall be accessible from the top of the boiler. The boiler control system shall measure supply and return temperatures and notify the operator if the direction of flow is reversed. The boiler control shall adjust to impending temperature changes in such a way to minimize fuel consumption and maximize efficiency. The control shall measure temperatures and the rate of change in those temperatures and respond early, rather than waiting for temperatures to exceed limit control settings.
3. Flue gas temperature sensor shall be mounted in the flue vent connector to monitor flue gas temperatures and reduce the blower speed when flue gas temperatures exceed 189°F. If the flue temperatures exceed 195°F, a forced boiler recycle results.
4. ASME Section IV safety relief valve sized to exceed the gross output of the boiler which shall be factory set to relieve the indicated pressure.
5. Water flow switch to prevent the burner operation during low water flow conditions.
6. High Temperature Limit, automatic and manual reset, to prevent burner operation if water temperature conditions rise above maximum boiler design temperature, wired to put the boiler into a hard lockout, requiring manual reset of the boiler primary control.
7. High and low gas pressure switches with manual reset and a range of 4 - 14 in W.C., wired to put the boiler into a hard lockout, requiring manual reset of the boiler primary control.
8. Low water cutoff (LWCO) device with manual reset. Boiler shall be fitted with a probe type LWCO located above the lowest safe permissible water level established by the boiler manufacturer. LWCO shall be UL listed and suitable for commercial hydronic heating service.

2.5 BOILER VENT AND INTAKE CONNECTIONS

A. Provide exhaust vent that is UL 1738 listed for use with Category II and IV appliances and compatible with operating temperatures up to 210°F, positive pressure, condensing flue gas service. UL certified vent material shall be stainless steel.

B. The exhaust vent system shall be in accordance with National Fuel Code, NFPA 54/ANSI Z221.3 and/or applicable provisions of local building codes.

C. Combustion air intake shall be capable of drawing air from inside the room or ducted from outdoors as indicated on the drawings. Ducted piping shall be PVC or galvanized smoke pipe that is sealed and pressure tight. Intake must be at least the same size as the inlet air connection on the boiler.

D. Combustion air intake shall be connected into the boiler vestibule not directly into the boiler blower assembly. Combustion air shall be preheated by passing around the exterior of the boiler furnace section before entering the pre-mix gas/air assembly.

E. Boiler shall be capable of common venting with an engineered vent system.

F. Venting shall have an equivalent length of up to 200 feet maximum when drawing air from inside the room or Venting shall have an equivalent length of up to 100 feet maximum and ducted combustion intake air shall have an equivalent length of up to 100 feet maximum.

2.6 BOILER CONTROL SYSTEM

A. The boiler control system shall be supplied with the factory assembled boiler and factory tested.

B. Boiler Control System shall provide safety interlocks and water temperature control. The control system shall be fully integrated into the boiler control cabinet and incorporate single and multiple boiler control logic, inputs, outputs and communication interfaces. The control system shall coordinate the operation of up to eight (8) fully modulating hot water boilers and circulation pumps. The control system shall simply control boiler modulation and on/off outputs based on the boiler water supply temperature and an operator adjusted set point. However, using parameter menu selections, the control system shall allow the boiler to respond to remote system water temperature, outside air temperatures and warm weather shut down (WWSD) or energy management system (BMS) firing rate demand, remote set point or remote start/stop commands.

C. Boiler Control: Using PID (proportional-integral-derivative) based control, the remote system water temperature shall be compared with a set point to establish a target boiler firing rate. If the secondary loop flow speed is greater than the primary loop flow speed, firing rate is increased in response to the decrease in secondary loop temperature. When the remote system temperature is near the boiler high limit temperature, the boiler supply sensor shall limit the maximum boiler supply temperature to prevent boiler high limit events. Alternately, using parameter menu selections, the control system shall allow the boiler to respond directly to boiler supply temperature and set point to establish a target boiler firing rate while remote system water temperature is used for display purposes only. Each boiler's fuel flow control valve shall be mechanically linked to the air flow control device to assure an air rich fuel/air ratio. All the automated logic required to ensure that pre-purge, post-purge, light-off, and burner modulation shall be provided.

D. Water Temperature Set point: When the controller is in the local control mode, the control system shall establish the set point based on outside air temperature and a reset function curve, or be manually adjusted by the operator. When enabled, the set point shall be adjusted above a preset minimum set point upon sensing a domestic hot water demand contact input. When in remote mode, the control system shall accept a 4-20ma or Modbus remote set point or firing rate demand signal from an external BMS.

E. Multiple Boiler Sequence: The controller shall incorporate its peer-to-peer communications on each connected boiler (up to eight [8] units) by using standard RJ45 ethernet cables. The control system shall allow the connected boilers to exchange signals as required to provide coordinated fully modulating lead/lag functions. It shall not be required to wire individual control signals between boilers. Multiple boilers shall be modulated in "Unison" (all at the same firing rate). To increase operational efficiency, the control system shall utilize both water temperature and firing rate-based boiler sequencing algorithms to start and stop the boilers and shall minimize the total number of boilers in operation. The control system shall start and stop

boilers when the water temperature is outside the adjustable temperature limit for longer than the adjustable time delay. In order to minimize temperature deviations, the control system shall start and stop the next boiler when the “lead” boiler is at an adjustable firing rate limit for longer than the adjustable time delay. The control system shall monitor both boiler lockout and limit circuits to automatically skip over those boilers that are powered down for maintenance, tripped or otherwise will not start. The boiler shall be run at low fire for warm-up for a preset low fire hold time. When enabled, warm weather shut down control logic shall prevent boiler operation. The controller shall also be capable of auto-rotation of the boilers based on user-selected run time hours.

F. User Interface: A touch screen message display shall be provided to display real time BTU/hr, numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and boiler historical information. In the event of a fault condition, the display shall provide help screens to determine the cause of the problem and corrective actions. Historical information shall include graphical trends, lockout history, boiler & circulator cycle counts and run time hours.

G. Circulator Control: The controller shall be capable of sequencing the boiler and system circulators. Simple parameter selections shall allow all three pumps to respond properly to various hydronic piping arrangements including either a boiler or primary piped indirect water heater. The controller shall perform circulator exercise to help prevent pump rotor seizing.

H. BMS Communications: The boiler control system shall network with a communication gateway to connect with applicable BMS system. The control shall allow for simultaneous communication for boiler peer-to-peer communication and BMS communication interfaces. Loss of BMS communication shall automatically transfer the boiler control to local operation. Boiler operation shall not be lost due to corrupt or loss of BMS communication. The boiler control system shall allow individual boiler limits, lockout, boiler and system temperatures and firing rate status to be readable and water set point, boiler firing rate, and start/stop command to be readable and writable.

I. External Data Transfer: The control system shall include the ability to transfer parameters from boiler to boiler. Upon completion of commissioning the first boiler, a USB flash drive shall allow settings to be "downloaded" from one boiler and "uploaded" into the next. Additionally, these files shall be able to be sent via email and "uploaded" to a remote technical support system. Additionally, it shall be possible to restore parameters to the "as shipped state" by selecting a "Factory Default" Button.

J. Archive History: All hard lockouts, soft lockouts (holds), sensor faults, Building Management System (BMS) signal faults, sequencer faults and limit string faults shall be recorded with a time and date stamp. The time and date log shall store up to 3000 alarm & events even after power cycle.” The alarm & event log must be downloadable to a USB thumb drive. The control shall include collect and store supply & return temperature, flame intensity and firing rate for at least 4 months. It shall be a simple matter to page through the boiler’s operation using the boiler mounted display or download the historical data to a USB thumb drive for off-site analysis. All data must be stored in standardly compatible CRV files.

2.7 BOILER TRIM

A. Provide trim devices including an ASME rated pressure relief valve set at the psi indicated on the drawings, combination water pressure and temperature gauge and water flow switch and low water cut-off to prevent burner operation during low water flow conditions.

2.8 BOILER INTAKE AND VENTING

A. Provide exhaust vents meeting UL listing for use with Category III and IV appliances and compatible with operating temperatures up to 480°F, positive pressure, condensing flue gas service. UL listed vents of Al 29-4C stainless steel must be used with boilers. Provide all required venting to provide a complete and fully functional operating system.

B. Combustion-Air Intake: Boilers shall be capable of drawing combustion air from the outdoors via stainless steel or PVC duct connected between the boiler and the outdoors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Gas Vent: Field verify gas vent routing before ordering vent materials. Locate gas vents to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading. Provide guy wires and all necessary accessories to support the breeching per the manufacturer’s installation requirements. Install gas vent per manufacturer’s installation instructions.

3.2 BOILER INSTALLATION

A. The installing Contractor is required to complete the PA Department of Labor and Industry form LIBI-302, "Intent to Install Boiler." When submitting the form, the installing contractor shall include all required fees and provide the owner with (3) copies of the submitted forms. The forms are available at the L and I website.

B. The installation is required to conform to all clearance requirements required by the PA Department of Labor and Industry. The installer is required to verify the completed installation will meet the clearance requirements. Should a clearance issue be encountered the installer is required to advise the engineer of the problem prior to completing the installation. The installer will be responsible for correcting clearance issues found after the installation is complete at no additional cost.

C. Provide emergency shut-off switches at each exit from the Boiler Room per the requirements of the PA Department of Labor and Industry.

D. Boiler Mounting: Install boilers on cast-in-place concrete equipment base. Coordinate sizes and locations of concrete bases with actual equipment provided. Construct concrete bases 6 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of boiler. 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. Anchor boiler per manufactures installation instructions.

E. Install gas-fired boilers according to NFPA 54.

F. Assemble and install all boiler trim. Install all required electrical devices furnished with boiler but not specified to be factory mounted. Install control wiring to field-mounted electrical devices.

3.3 PIPING CONNECTIONS

A. Where installing supply and return piping and all accessories in the area of the boiler(s), allow space for service and maintenance and clearances as required by PA Labor and Industry.

B. Connect hot-water piping to supply- and return-boiler connections with shutoff valve and union or flange at each connection.

C. Connect boiler drain with a condensate neutralization tube and rout to the nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with dirt leg, shutoff valve, and union or flange. Piping shall be at least full size of gas-train connection. Provide a reducer if required. Provide all required venting from the gas train per manufactures installation requirements.

E. Install piping from safety relief valves to nearest floor drain.

3.4 BOILER INTAKE AND VENT CONNECTIONS

A. Install and support boiler intake and vent connections per manufacturer’s instructions.

3.5 STARTUP, TRAINING AND DEMONSTRATION

A. Provide services of a manufacturer's authorized representative for start-up services. Provide completed start-up report to the owner.

B. Provide training and demonstration services to the owner’s representative. The training will be on-site and consist of a minimum or 8 hours. Schedule training through the owner providing a minimum of 40 hours’ notice.

END OF SECTION 23 52 88

SECTION 23 52 90 – FIRE TUBE CONDENSING BOILERS

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 packaged, factory-fabricated and assembled, natural gas-fired, fire-tube condensing boilers, sequencing control panel, boiler trim and other accessories for generating hot water.

1.3 SUBMITTALS

A. Provide submittals that include a listing of any and all exceptions to the requirements indicated in the construction documents. Should there be no exceptions, the submittal will indicate this. Submittals that do not have this listing will be returned without review.

B. Shop Drawings: For boilers, boiler trim, and accessories. Provide wiring diagram for power, signal, and control wiring.

C. Product Data: Submit manufacturer's technical product data, including rated capacities, weights (shipping, installed, and operating), installation and start up instructions, along with furnished accessory information.

D. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 80%, 60%, 40% 20%, and 7% input firing rates at incoming water temperatures ranging from 80°F to 160°F.

E. Prior to flue vent installation, provide engineered calculations and drawings to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.

F. Pressure Drop Curve: Submit pressure drop curve for flows ranging from 0 GPM to maximum value of boiler. If submitted material is different from that of the design basis, boiler manufacture shall in-cur all costs associated with reselection of necessary pumps.

G. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all boilers through one source and from a single manufacturer, regularly engaged in production of forced draft high efficiency condensing boilers whose products have been in use for similar services for a minimum period of 5 years.

B. 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.

C. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

D. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.6 WARRANTY

A. The boiler manufacturer shall provide a guarantee, in writing, stating the boiler(s) will be free of defects for one year after the date of substantial completion for the project. The manufacturer shall agree to repair or replace at manufacturer's expense any defective parts. The boilers shall receive such factory tests as are deemed advisable by the manufacturer to check construction and operation.

B. The pressure vessel shall be guaranteed against thermal shock for 10 years when utilized in a closed loop hydronic heating system with a maximum temperature differential rating of 170°F. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement while fired on natural gas. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.

C. The pressure vessel shall also carry a 10-year warranty against material and workmanship defects.

D. The heat exchangers shall be guaranteed against flue gas corrosion for a period of 5 years from factory shipment.

E. All other parts, not covered by the above warranties, shall carry a full one-year warranty. This shall include all electrical and burner components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements provide boilers manufactured by Fulton or Aerco as indicated on the drawing schedule as an alternate bid.

2.2 GENERAL BOILER DESCRIPTION AND CONSTRUCTION

A. Each boiler shall be completely factory assembled as a self-contained unit and shall be thoroughly tested, and properly packaged for shipping.

B. The primary and secondary (condensing) pressure vessel design and construction shall be in accordance with Section IV of the ASME Code for heating boilers. The maximum water working pressure shall be 160 psi and the maximum design temperature shall be 210 degrees F. Boiler shall also comply with CSD-1 Code requirements.

C. The Forced Draft Combustion Boiler shall be UL approved as a Direct Vent Boiler. The boiler will require a stack utilizing AL-29-4C or equivalent. The boiler shall be capable of operating with an exhaust draft not exceeding –0.04” w.c. and a combined air intake venting and exhaust venting pressure drop not exceeding 0.40” w.c.

D. The vessel shall be SA-53B ERW pipe or SA-516 Grade 70 plate. The heads shall be SA-516 Grade 70 plate. The pressure vessel shall be fully insulated with high temperature insulation. Adequate openings shall be provided for access to the waterside of the boiler.

E. The condensing section of the exhaust pipes shall be constructed of SAF 2205 Duplex Stainless Steel and manufactured in accordance with Section VIII of the ASME Code for Heating Boilers.

F. The boiler shall be a fire-tube design. The furnace location shall be such that all furnace components are within water-backed areas.

G. Temperature and pressure gauges shall be provided with the boiler.

H. The boiler(s) shall operate with CO emissions less than 35 PPM corrected to 3% O2 and NOx emissions less than 70 PPM corrected to 3% O2 over the entire turndown range.

2.3 BOILER DESIGN

A. External convection and radiation heat losses to the boiler room from the boiler shall be less than 0.5% of the rated boiler input.

B. The boiler shall be designed to operate in a condensing mode while firing on natural gas, in order to extract the latent heat from the combustion products. Operating on natural gas and with a return water temperature of 80°F, the boiler shall have a minimum acceptable fuel-to-water efficiency of 93% at the full rated input capacity and 99% at the low fire rated input capacity. .

C. The boiler shall have no minimum return water temperature requirements when fired on natural gas.

D. A zero flow condition will not cause any harm to the boiler. Flow switches and primary/secondary piping arrangements are not required.

2.4 BOILER CONTROLS

A. Provide flame safeguard controls capable of providing linkage-less modulation and shall provide the following:

1. The control shall provide a 30 second pre-purge and post-purge time.
2. The control shall maintain a running history of operating hours, number of cycles, and the most recent six control lockouts
3. The control is connected to a display module, which is capable of retrieving the information listed above.

B. Each boiler shall be equipped for fully modulating operation with a 5:1 turndown ratio on natural gas. Airflow shall be controlled by a butterfly valve connected to a precision servomotor. Fuel flow shall be controlled by a butterfly valve.

C. Each burner shall be a forced draft flame retention type automatic burner. The burner housing shall be cast aluminum monobloc type construction. The burner-mounting flange must support the burner weight on the boiler independent of any support. Burner shall be furnished with a stainless steel flame retention type of combustion head, capable of withstanding temperatures up to 1400 degrees F. This combustion head shall incorporate a diffuser and sleeve that is to direct excess air either around the flame or directly through the diffuser vanes. Adjustment to the diffuser insertion shall be made external to the burner and can be made while the burner is in full operation. Burner must have a flame inspection window positioned at the rear center of the burner housing. Flame shall be viewed without removing any covers. Burner shall come complete with a high efficiency, totally enclosed fan cooled motor (TEFC) and a dynamically balanced blower wheel. The blower wheel must be of the energy efficient, self-cleaning, reverse inclined fan blade type. The sound rating of the burner shall not exceed 80 dBa when measured at 3 feet from the burner.

D. The burner gas ignition system for the main gas shall utilize natural gas as the fuel source. The gas pilot system components shall include spark ignited pilot assembly, 7000 Volt ignition transformer, pilot safety shut off valve, pilot gas pressure regulator and manual gas shutoff cock. The burner oil ignition system shall be by means of a separate 2x5000 Volt direct spark ignition system.

E. The burner shall be equipped with an integral burner mounted control panel consisting of necessary motor starters, overloads, lights and switches. The burner shall be equipped with a single pole double throw air pressure switch that will not allow burner to start if there is insufficient combustion air, which is checked prior to each ignition attempt. Before the burner can start the airflow switch must be in the open position to prove the switch is not giving a false signal of sufficient combustion air pressure

F. Provide the following boiler safety controls:

1. Operating Temperature Controller for automatic start and stop.
2. High Limit Temperature Controller with manual reset.

3. One Low Water Cutoff Probe in boiler shell.
4. Air Safety Switch to prevent operation unless sufficient combustion air is assured.
5. Flame detector to prove combustion.

G. All controls are to be burner or panel mounted and located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to UL requirements. Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler. Electrical power supply shall be as indicated on the contract drawings. A control circuit transformer shall be factory supplied, wired and mounted.

H. When multiple boilers are to be installed in a common hydronic loop, a Fulton ModSync Boiler Sequencing System shall be provided.

2.5 MAIN FUEL TRAIN COMPONENTS

A. Each boiler shall be provided with a factory mounted main gas train. The gas train shall be fully assembled, wired, and installed on the boiler and shall comply with CSD-1 code. The maximum pressure rating of the components shall not be less than one psi. The gas train shall consist of at least two manual shutoff valves, one gas pressure regulator, one automatic safety shutoff valve with prove of closure, one flow control valve, one high gas pressure switch, and one low gas pressure switch. The automatic safety shutoff valve and flow control valve may be the same valve. A pilot gas train, when supplied, shall comply with the same code and maximum gas pressure rating as the main gas train.

2.6 BOILER FITTINGS

A. Each boiler shall be supplied with an ASME Section IV safety relief valve. The safety relief valve size shall be in accordance with ASME code requirements.

B. Provide temperature and pressure gauges which are to be mounted on top of the boiler.

C. Provide a condensate drain connection in the exhaust outlet. A Fulton condensate drain kit will be provided to collect and drain the flue gas condensate.

D. The water supply and return connections on the boiler shall be 150# flanged connections. The size shall be 6”. The water connections shall not be designed to support any external mechanical load from the piping system.

2.7 VENTING

A. The boiler shall be UL approved as a direct vent boiler. Direct venting shall be accomplished by utilizing AL29-4C material and be rated for positive pressure. The exhaust vent shall be a minimum of 10” diameter for venting runs up to 50’ in length. Vent piping shall be installed in accordance with applicable national and local codes and per the boiler manufacturers’ recommendations.

B. The exhaust vent must be UL Listed for use with Category III and IV appliances and compatible with operating temperatures up to 480°F, positive pressure, condensing flue gas service. UL listed vents of Al 29-4C stainless steel must be used with boilers. Provide all required venting to provide a complete and fully functional operating system.

C. The air intake connection shall be provided with a flexible rubber coupling. The connection size shall be a minimum of 8” diameter PVC pipe size for venting runs up to 50’ in length. The connection shall not be designed to support any external mechanical load from the venting system.

2.8 BOILER SEQUENCE CONTROL

A. Provide a ModSync boiler sequence control system to sequence the boiler system and to monitor, enable/disable and control the firing rate of each boiler in the system. The sequence control system shall control the boiler system per the following:

1. The sequencing system shall monitor the outdoor temperature and calculate a hydronic loop temperature set point based on touchscreen selectable user-defined values. The boiler sequencing system will stage operation of the hydronic boilers based on the difference between the actual hydronic loop temperature and the calculated outdoor air reset hydronic loop temperature set point.

2. When a requirement for heat is determined by the boiler sequencing system, the lead boiler is energized and its firing rate is maintained at low fire. If the hydronic loop temperature continues to decrease, the boiler sequencing system will enable a lag boiler. The first lag boiler is energized and the lag boiler's firing rate is maintained at low fire.

3. As additional heat is required, the boiler sequencing system will enable the remaining lag boiler stages individually until all of the available boilers in the hydronic loop have been energized. Each boiler will remain at low fire until all of the stages have been enabled.

4. If all of the hydronic boilers are enabled and additional heat is required, the boiler sequencing system will release the boilers to modulate. The boilers will modulate together as a single unit to keep the boiler system at the lowest possible firing rate, while satisfying the building load demands.

5. As the hydronic loop temperature increases, the boiler sequencing system will decrease the firing rate of the hydronic boilers to maintain the hydronic loop temperature. If all of the hydronic boilers are at low fire and the hydronic loop temperature continues to rise, the boiler sequencing system will begin to stage the boilers off. The first lag boiler stage energized will be the last stage to be disabled. The hydronic boilers will continue to be disabled by the boiler sequencing system based on the temperature rise of the hydronic loop. The lead boiler is disabled when the hydronic loop temperature reaches a selectable value referenced around the hydronic loop set point.

B. The boiler sequencing system shall be a microprocessor based process controller with a graphical user interface and touchscreen capabilities. The active touchscreen display area will be a minimum of 5.7" with a color TFT display resolution of 256 colors.

C. The sequencing system enclosure will be NEMA 4X construction. The enclosure shall be designed with the ability of be located in outdoor environments. Power requirements for the boiler sequencing panel will be 120/60/1. The sequencing system shall be wall mounted, stand-alone unit. Password requirements will prevent access to any of the screens where system configuration parameters can be adjusted, while maintaining the ability of viewing the system performance.

D. Outdoor and Supply Header Temperature sensors supplied with the boiler sequencing system shall be PT-100 RTD type for precise temperature monitoring. Return Temperature monitoring capabilities shall be available and used when BTU calculation is used. The boiler sequencing system will also have the ability to receive temperature values from the Building Management System through a communication protocol. Each temperature input shall have a selection button that allows for independent configuration of where the temperature value will be received from.

E. Multiple Status and Configuration Screens shall be available for easy interpretation of the hydronic loop status and simplified control configuration of the multiple hydronic boiler system. At a minimum the following screens shall be available:

1. Outdoor Reset Configuration
2. Set back Schedule
3. Lead/Lag Configuration
4. Boiler Configuration
5. System Status
6. Alarm Status
7. Alarm History.

F. Provide Outdoor Reset to adjust the hydronic loop temperature set point based on the outdoor temperature. As the outdoor temperature increases, the hydronic loop set point can decrease while still maintaining the desired building temperature. The boiler sequencing system shall provide Outdoor Reset Configuration Screens that include all of the parameters required to effectively configure the hydronic loop set point based on the outdoor temperature.

1. The boiler sequencing system will provide an adjustable reset schedule based on the outdoor temperature. A linear outdoor reset ratio will be determined based on user-defined hydronic loop temperatures at 50ºF and 0ºF outdoor temperatures. Outdoor temperature configuration variables shall be adjustable through the touchscreen to match designed reset schedule requirements. A reference graphic detailing the calculated reset ratio will be displayed on the Outdoor Reset Configuration screen.
2. Minimum and maximum loop temperature parameters will prevent the outdoor reset schedule from operating outside of a user-defined temperature range.
3. A user-defined Outdoor Temperature Disable parameter will be provided to disable the hydronic loop if a predetermined outdoor temperature is reached. A hysteresis variable will prevent the hydronic system from re-enabling until the outdoor temperature decreases a user-defined amount.
4. To meet multiple system control configurations, set point mode adjustment capabilities will be included as standard with the boiler sequencing system. Set point Modes will include Outdoor Reset, 4-20mA Remote Set point, BMS Communication or Manual. The set point mode shall be field adjustable by a touchscreen selection button on the set point configuration screen.

G. Setback Configuration Screens shall be provided to adjust the hydronic loop set point based on Day of the Week/Time of Day variables. Multiple setback schedules shall be available based on whether the building is in Occupied or Unoccupied mode. Building Mode selection shall be determined by a user-defined Time of Day / Day of Week touchscreen entry. The Building Mode will automatically change between Occupied and Unoccupied based on the user programmed day and times. Manual Building Mode control shall also be available via a Setup menu. Building Mode shall be indicated on the Loop Status Screen for ease of reference. An Anticipation Mode feature shall be provided to automatically switch to Occupied Mode a selectable number of hours earlier than scheduled if the outdoor temperature lowers below a user-defined temperature during the Unoccupied Mode.

H. Lead/Lag Configuration screens shall be used to configure how the hydronic boilers will be assigned and enabled in the control sequence. The boiler sequencing system will include automatic rotation of the lead boiler based on a user configured lead boiler cycle count or run hours, whichever setting occurs first. When the lead cycle or run hours rotation value is reached, the boiler sequencing system will assign each boiler's position in the lead/lag sequence based on their previous operating history. Boiler sequencing systems that simply rotate the lead position to the next boiler in the sequence will not be acceptable due to their ineffective ability of maintaining an even cycle count across all of the boiler stages in the hydronic loop.

I. The boiler sequencing system will stage the boilers based on a PID generated control variable value. The Proportional, Integral and Derivative values shall be user-defined through the Lead/Lag Configuration screen. Each lag boiler stage will be enabled and disabled based on a user-defined control variable percentage. Properly tuned loops will provide temperature control accuracy up to +/- 2ºF, based on load demand. Lead boiler start and stop parameters shall be user-defined through the touchscreen operator interface. A Manual Reset parameter will allow the Proportional Band to be shifted around set point.

J. The boiler sequencing system will have the ability to monitor the outlet temperature of each hydronic boiler in the system. This feature is beneficial for systems that will incorporate variable flow designs. If the boiler outlet temperature exceeds set point by a user-defined amount, the boiler sequencing system will automatically lower the firing rate of the boiler to help prevent a high limit trip at the boiler. As the boiler outlet temperature decreases below a defined variable, the boiler sequencing system will allow the firing rate of the boiler to increase.

K. The boiler configuration screens shall display information regarding each boiler stage in the boiler system loop. The screens will detail and provide the following:

1. Boiler status.
2. Boiler cycles, run hours and cycle / hour ratios.
3. Boiler outlet temperature.
4. Boiler enable / disable touchscreen selection.
5. Boiler auto / manual touchscreen control mode selection.
6. Boiler manual start / stop and firing rate control.

L. The boiler sequencing system shall include capabilities to enable/disable the boilers through the operator interface. Boilers that are disabled will not be included in the sequencing logic.

M. The sequencing system will monitor the operation and status of all temperature sensors and hydronic boilers in the loop. Sensor errors will be annunciated on the boiler sequencing systems alarm screen. If an outdoor temperature sensor error occurs, the boiler sequencing system will automatically switch to manual set point mode and will annunciate the alarm condition.

N. The sequencing system will start a timer when each boiler stage is enabled to run. If the main gas valves do not energize within the user-defined timeframe then a local limit is preventing the boiler from operating. The boiler sequencing system will immediately remove the boiler from the lead/lag sequence and annunciate that a local boiler error exists. An automatic reset option will allow the boiler to be re-enabled after a user-defined timeframe has elapsed.

O. An Alarm Status screen will give a text description of any current alarm conditions. Boiler sequencing systems that use codes or symbols to detail alarm conditions will not be acceptable. The boiler sequencing system will automatically adjust the boiler sequencing status and remove the boiler from the sequencing logic if an alarm occurs. The boiler will automatically be added back into the rotation loop as soon as the boiler sequencing system senses that the alarm has been cleared.

P. The boiler sequencing panel will include an Alarm History screen that allows for the last 100 alarm conditions to be viewed. A Date/Time stamp and text description of each alarm condition in the history will be available.

Q. A System Status screen will detail current outdoor, hydronic system and control variable values. The status screen will also display enable/disable and firing rate information for each of the boilers in the hydronic loop.

R. Trending of the supply temperature, system setpoint and outdoor temperature will be displayed to provide system operational history for tuning of the PID and lead/lag parameters.

S. The boiler sequencing system will have the ability to communicate to a Building Management System using multiple protocols including Modbus RTU, BacNet, LonWorks or N2. Standard point mapping will be provided with the boiler sequencing system. Selection of modbus serial connectivity (RS-232/RS-485) and baud rate will be field-adjustable using a configuration screen on the boiler sequencing system. Selection of BacNet MS/TP or IP shall be field adjustable through a dip-switch setting. The ability to field adjust custom project points will be available through a easy to configure and freely distributed software package.

T. The boiler sequencing system shall have the ability for the internal control logic to be field-modified to meet system design changes that may arise during commissioning of the hydronic system or future system expansion. The control logic shall be field adjustable through a downloadable, freely distributed software package that does not require a licensing fee.

U. Boiler circulator pumps control capabilities shall be provided by the boiler sequencing system for hydronic loops. A call for heat at the boiler will enable the boiler circulator(s). The boiler sequencing system will provide a user-defined time delay to keep the pump energized for a defined timeframe after the boilers have been turned off.

V. The boiler sequencing system will provide the capability to interface and control the Main System pumps. System pump control can be accomplished through enable/disable based on outdoor temperature. Hydronic system differential pressure or delta temperature can also be monitored to automatically adjust the system pump flow based on the building load demands, decreasing the energy usage.

PART 3 - EXECUTION

3.1 BOILER INSTALLATION

A. The installing Contractor is required to complete the PA Department of Labor and Industry form LIBI-302, “Intent To Install Boiler.” When submitting the form, the installing contractor shall include all required fees and provide the owner with (3) copies of the submitted forms. The forms are available at the L and I website.

B. Provide emergency Shut-off switches at each exit from the Boiler Room per the requirements of the PA Department of Labor and Industry.

C. The installation is required to conform to all clearance requirements required by the PA Department of Labor and Industry. The installer is required to verify the completed installation will meet the clearance requirements. Should a clearance issue be encountered the installer is required to advise the engineer of the problem prior to completing the installation. The installer will be responsible for correcting clearance issues found after the installation is complete at no additional cost.

D. Equipment Mounting: Install boilers on cast-in-place concrete equipment base. Coordinate sizes and locations of concrete bases with actual equipment provided. Construct concrete bases 6 inches high and extend base not less than 6 inches in all directions beyond the maximum dimensions of boiler. 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.

E. Install gas-fired boilers according to NFPA 54.

F. Install all required boiler trim. Install electrical devices furnished with boiler and boiler sequencing system that are required but not factory mounted. Install control wiring to field-mounted electrical devices.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to boiler to allow service and maintenance.

B. Connect boiler drain with a condensate neutralization tube and rout to the nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

C. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.

D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide gas-train venting as required for the gas train specified in Part 2.

E. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting: Provide all required venting as indicated on the drawings.

3.3 FIELD QUALITY CONTROL

A. Engage the services of a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to provide operational testing of the completed boiler system.

3.4 DEMONSTRATION

A. Engage the services of a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain boilers and the boiler sequencing control system.

END OF SECTION 23 52 90

SECTION 23 57 20 – SHELL & TUBE HEAT EXCHANGERS

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 water to water shell-and-tube heat exchangers.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Tube-removal space.
2. Structural members to which heat exchangers will be attached.

D. Manufacturer Seismic Qualification Certification: Submit certification that heat exchanger, accessories, and components will withstand seismic forces defined in Division 23 Section "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 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. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."

B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

C. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

PART 2 - PRODUCTS

2.1 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers:

1. API Heat Transfer Inc.
2. Armstrong Pumps, Inc.
3. ITT Industries; Bell & Gossett.
4. Taco, Inc.
5. Thrush Company, Inc.

B. Configuration: U-tube with removable tube bundle.

C. Shell Materials: Steel.

D. Head materials: steel with removable cover flanged and bolted to shell.

E. Tube: Seamless Copper, 3/4” diameter.

F. Piping Connections:

1. Shell: Flanged or threaded with drain and vent connections.
2. Head: Flanges or threaded inlet and outlet fluid connections.

G. Support Saddles: provide saddles of material similar to shell.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

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

3.2 HEAT-EXCHANGER INSTALLATION

A. Provide welded and painted steel base for the heat exchanger. Fabricate structural steel base to support the weight of the heat exchanger with structural angles, channels and pipe. Install unit with the centerline approximately 4'-0" above the floor.

B. Install shell-and-tube heat exchangers on concrete base.

3.3 CONNECTIONS

A. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

B. Install shutoff valves at heat-exchanger inlet and outlet connections.

C. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

D. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

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

3.5 CLEANING

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

END OF SECTION 23 57 20

SECTION 23 73 80 – PACKAGED INDOOR AIR HANDLING UNITS

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 packaged blower coil type, air-handling units with coils, filters and other accessories for indoor installations.

B. Source Limitations: Obtain all Packaged Units through one source from a single manufacturer, regularly engaged in production of the units.

1.3 SUBMITTALS

A. Product Data: For each packaged air-handling unit provide the following:

1. Unit dimensions and weight.
2. Cabinet material, insulation details and accessories.
3. Provide fan performance curves with system operating conditions indicated.
4. Provide coil-performance ratings with system operating conditions indicated.
5. Coil connection locations and sizes.
6. Dampers, including housings, linkages, and operators.
7. Filters with performance characteristics.
8. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.

B. Provide Operation and Maintenance Data for all packaged air handling units.

1.4 QUALITY ASSURANCE

A. Units to be designed and tested in compliance with AHRI 430 air delivery ratings per AHRI 430-2014.

B. Units to be designed and tested in compliance with AHRI 260-2001.

1.5 COORDINATION

A. Where required, coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags on each section to indicate location and orientation in direction of airflow. Each section shall have lifting points to allow for field rigging and final placement of section.

B. Store units in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

C. Deliver units to site with electronically commutated fan motors factory mounted in units. If these components are not completely assembled, contractor shall be responsible for all expenses associated with installation, testing, and vibration balancing of fan(s).

1.7 WARRANTY

A. Indoor Units: provide written warranty provided by the unit manufacturer indicating all packaged air handling units will be warranted for a period of 1 year from date of shipment. The warranty will include replacement of any of the unit's components that fail in materials and/or workmanship within the warranty period.

1.8 EXTRA MATERIALS

A. In addition to the equipment and materials furnished with the air handling units, 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. Filters: Two complete set for each air-handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide Packaged Air Handling Units manufactured by The Trane Company. Subject to review, equipment meeting the full requirements of the specifications and project installation limitations (i.e. size and weight) and manufactured by the following will be considered:

1. Johnson Controls

B. General Description: Provide factory assembled units, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing box with dampers. Unit manufacturer to provide vibration spring isolators required to hang horizontal units.

2.2 UNIT CASING

A. The entire air handler shall be constructed of galvanized steel. The removal of access panels shall not affect the structural integrity of the unit once the unit is installed. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit. Access panels shall be on both sides or front of the unit in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

B. Units shall ship as one or two modules completely factory-assembled including all coils, fans, motors, drives, dampers and filters.

C. Access Panels: Removable access panels shall be provided on both sides of the unit to facilitate service access to drain pans, motors, drive components and bearings. Panels shall be gasketed. Access panel for filter removal shall be provided on both sides of the unit.

D. Cabinet: Casing shall be manufactured of heavy gauge galvanized steel. All removable panels shall be gasketed to minimize air leakage.

E. Provide high density, matte-faced insulation on the interior surface of unit casing. Insulation shall have a minimum R-Value of 4 and shall be UL Listed. The insulation shall comply with NFPA-90A and B requirements.

2.3 HYDRONIC COILS

A. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

B. Construct coil casings of galvanized steel. End supports shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

C. Supply and return header connections shall be clearly labeled on outside of units such that direction of coil water-flow is counter to direction of unit air-flow. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water. Headers shall be constructed of round copper pipe. If unit is provided with 1/2 inch O.D. coils, the minimum tube wall thickness shall be 0.016 inch thick copper. If unit is provided with 3/8 inch O.D. coils, the minimum tube wall thickness shall be 0.014 inch thick copper. All fins shall be aluminum.

2.4 DRAIN PAN

A. Provide a drain pan fabricated of a noncorrosive material, either a polymer plastic or stainless steel, and double-sloped to allow condensate drainage. Coils to be mounted above the drain pan, not in the drain pan, to allow the drain pan to be fully inspected and cleaned. The drain pan is to be removable for cleaning. The drain connection is at the lowest point of the drain pan.

2.5 SUPPLY FANS

A. Fans are forward curved, centrifugal blower type equipped with heavy-duty adjustable speed V-belt drive. The fan shaft is supported by heavy-duty, permanently sealed ball bearings. All fans are dynamically balanced.

2.6 MOTORS AND DRIVES

A. Provide single-phase or three phase motors as required. All motors have a plus or minus 10 percent voltage utilization range. All standard motors are open drip-proof with permanently sealed ball bearings, internal current and thermal overload protection and a minimum 1.15 service factor. Motors are to be factory installed and wired to the air handler junction box.

B. All motors shall be factory-installed and run tested. To facilitate field replacement of motors, a removable fan inlet cone shall be provided on the drive side of the fan/motor assembly.

C. Motors shall be ECM programmable type. The motor shall be preprogrammed in the factory to meet the specified airflow requirements.

D. Motors shall be selected to operate continuously at 104 F. ambient without tripping on overloads. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

E. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in star-up and services personnel in maintenance:

1. Fan motor part number

2. Fan design RPM and motor HP

2.7 ANGLE FILTER MIXING BOX

A. Where indicated, provide mixing boxes. Mixing boxes are to be constructed of heavy-gauge galvanized steel complete with two low-leak parallel blade dampers that are factory-linked together. Provide 1/2" extendible drive rod that can be used for actuator connection, either internally or externally. Damper blades are to be extruded aluminum having interlocked PVC extruded edge seals. Damper frame seals are PVC extruded forms interlocked to the damper frame and provided with a continuous edge seal to the blades. Damper seals are stable in the temperature range of -50°F to 230°F. Mixing boxes also include two side access panels as standard to provide access to the unit's internal components.

B. Provide 2" thick MERV 8 throwaway filters.

2.8 FILTER BOX SECTION

A. Where indicated provide filter box with two inch MERV 8 filters. Units have a standard flat filter rack that is sized for less than 500 feet per minute at nominal airflow.

2.9 CONDENSATE OVERFLOW PROTECTION SYSTEM

A. Where noted on the drawings, provide a float switch installed in the primary drain pan to detect a high condensate water level. Should the condensate level rise in the primary drain pan the float switch will sense the high water level and stop the supply fan and close the heating control valve and outdoor air damper where applicable. The float switch shall have manual reset. The switch shall be factory installed by the unit supplier or field installed by the installing contractor.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the work. Examine roughing-in for hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install packaged air-handling units level and plumb, in accordance with manufacturer's written instructions. Install horizontal units suspended from the structure with threaded rod and spring isolators.

B. Provide an installation where adequate access space, around air-handling units, is provided for service and maintenance.

C. Provide all necessary control wiring for the condensate overflow protection system.

D. At the direction of the Owner's Representative the contractor shall remove and dispose of filters from the respective units and install a new filter obtained from the Extra Materials required in Part 1 of this specification. If additional filter installation is not required, forward filters to the owner as extra stock, at the completion of the project.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to the unit to allow service and maintenance. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

B. Hot- and Chilled-Water Piping: Install shutoff valve and union or flange at each coil supply connection. Refer to contract drawings for piping connection details.

C. Coordinate duct installations and specialty arrangements with schematics on Drawings and with requirements specified in Section 233113 "Metal Ducts" and Section 233300 "Air Duct Accessories."

D. Connect duct to air-handling units with flexible connections.

3.4 STARTUP SERVICE

A. Provide all factory recommended startup service.

B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

3.5 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.6 DEMONSTRATION

A. **Train** Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 23 73 80

SECTION 23 82 05 – HYDRONIC DUCT COILS

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 air coils that are not an integral part of air-handling units.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include material descriptions, dimensions of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil.

B. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

PART 2 - PRODUCTS

2.1 WATER COILS

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

1. Capital Coils..
2. Trane.
3. USA Coil & Air

B. Coils to be constructed with plate fins and seamless tube construction and be tested and rated according to ARI 410. Coils shall be leak tested at 400 PSI air pressure under warm water and shall be guaranteed for 200 psig water working pressure and 300 degrees working pressure.

C. Tubes: minimum 5/8” OD with .020” seamless copper.

D. Fins: Aluminum minimum thickness 0.0065”.

E. Casing: 16 gauge galvanized-steel channel frame for flanged mounting.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb with sufficient clearance for normal service and maintenance. Supports coils as required.

B. Install piping adjacent to coils to allow service and maintenance.

C. Hydronic Piping: provide connections to the inlet of heating coils to include shutoff valve, strainer and union. Outlet connections to include union, control valve, balancing valve and shutoff valve. Insulate heating coils per requirements of Specification Section 230700.

D. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible." Provide duct access doors in the duct transition on the entering air and leaving air side of each duct coil.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to coils to allow service and maintenance. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping.

END OF SECTION 238205

SECTION 23 82 40 – HYDRONIC CABINET HEATERS

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 Cabinet heaters with centrifugal fans and hot-water coils.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Samples for Initial Selection: Provide color charts, for units with factory-applied color finishes, for color selection by the Architect.

C. Operation and Maintenance Data: For cabinet heaters.

1.4 QUALITY ASSURANCE

A. Obtain all cabinet heater units through one source from a single manufacturer, regularly engaged in production of the units.

1.5 EXTRA MATERIALS

A. In addition to the filter supplied with each cabinet heater, provide two extra set of filters for all units installed on the project. When directed by the owner's representative, install both sets of filters if necessary. If additional filter installation is not required all filters shall be given to the owner as extra stock, at the completion of the project.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

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

1. Airtherm; a Mestek Company.
2. Trane.
3. Zendor Rittling.
4. Sigma.
5. USA Coil & Air.

B. Each unit shall include a cabinet, coil, fan wheel(s), fan casing(s), fan board, and motor(s). The fan board assembly shall be easily removable and include a quick-disconnect motor plug. The construction shall be minimum 18-gage galvanized steel, and continuous throughout the unit. The unit shall be acoustically and thermally insulated with closed-cell insulation. All panels are made rigid by channel forming.

1. Horizontal Cabinet Units: All panels to be minimum 18-gage galvanized steel, including the bottom panel. The hinged access door is flush with front panel. Bottom panels ship with tamperproof screw fasteners and safety chain.
2. Concealed/Recessed Units: Exposed panels on recessed units to be minimum 18- gage steel construction and ship separate from the unit. Bottom panels on horizontal recessed models ship with tamperproof screw fasteners and safety chain.

C. Cabinet Finish: Refer to drawing schedules for finishes required for each cabinet heater. Provide units with one of the following finishes, as noted on the drawings:

1. If the drawings indicate a “Primer” finish; provide a factory applied baked enamel primer.
2. If the drawings indicate a “Standard” color; provide a factory applied baked enamel color, selected by the Architect from the manufacturer’s standard color chart.
3. If the drawings indicate a “Custom ” color; provide a factory applied baked enamel in a custom color as selected by the Architect.

D. Filters: Filters to be located behind an integral access door on horizontal type units. Filters to be 1” pleated media throwaway (Farr 30/30).

E. Hot-Water Coil: Hot water coils to be burst tested at 450 psig and leak tested at 100 psig under water. Maximum main coil working pressure to be 300 psig. Tubes and u-bends to be 3/8” OD copper. Fins to be aluminum and mechanically bonded to the copper tubes. Coil stubouts to be 5/8” OD copper tubing.

F. Fans: Provide aluminum fan wheels to be centrifugal forward-curved and double-width. Fan wheels and housings to be corrosion resistant. Fan housing construction to be formed sheet metal.

G. Motors: Provide brushless electronically commutated motors (ECM) factory programmed and run-tested in assembled units. The motor controller is mounted in a control box with a built-in integrated user interface and LED tachometer. Provide adjustment through momentary contact switches accessible without factory service personnel on the motor control board. Motors will soft-ramp between speeds to lessen the acoustics due to sudden speed changes. Motors can be operated at three speeds or with a field-supplied variable speed controller. The motor will choose the highest speed if there are simultaneous/conflicting speed requests. All motors have integral thermal overload protection with a maximum ambient operating temperature of 104°F and are permanently lubricated. Motors are capable of starting at 50 percent of rated voltage and operating at 90 percent of rated voltage on all speed settings. Motors can operate up to 10 percent over voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install cabinet unit heaters to comply with NFPA 90A. Suspend cabinet heaters from structure with elastomeric hangers.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Where required, connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

A. Perform field tests and inspections as required by the manufacturer. Provide test reports.

B. Remove and replace malfunctioning units and retest as specified above.

C. At the direction of the owner’s representative, the contractor shall install the extra filters in the respective equipment. If no additional installation is required, the contractor shall forward, to the owner, all extra filters. When forwarding materials obtain a receipt for any materials forwarded.

END OF SECTION 23 82 40

SECTION 23 82 50 – HYDRONIC UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes propeller unit heaters with hot-water coils.

1.3 QUALITY ASSURANCE

A. Obtain all unit heaters through one source from a single manufacturer, regularly engaged in production of the units.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit type and configuration.

B. Operation and Maintenance Data: For propeller unit heaters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Airtherm.
2. Sterling.
3. Rittling
4. Sigma
5. Trane.

2.2 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor with adjustable discharge louvers.

2.3 CABINETS

A. Constructed with minimum 18 gauge cold rolled steel with exterior panels painted with manufactures standard color epoxy powder coated paint.

B. Horizontal Units:

1. Casing consists of top/back and side halves. Both halves are joined on top and back with hex head screws. Top casing is furnished with threaded hanger connections for suspension of unit.

2. Provide die-formed fan venturi on back half. Units shall be equipped with horizontal, individually adjustable louvers.

C. Vertical Units:

1. Casing includes top and bottom pieces joined by corners and additional hardware. Top casing is furnished with threaded hanger connections for suspension of unit

2. Furnish a two-way louver to provide specific air throw pattern.

2.4 COILS

A. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 degrees F. Test for leaks to 350 psig underwater.

2.5 FAN

A. Propeller type with non-conducting, spark-proof aluminum blade wheel with steel hub directly mounted on motor shaft in the fan venturi. Provide finger proof fan guard constructed of welded steel rod and finished with a standard black epoxy powder coat paint. Units mounted below 8 feet from the floor must be equipped with an OSHA fan guard to meet ETL and OSHA requirements.

2.6 FAN MOTORS

A. Permanently lubricated, two-speed, permanent split capacitor, totally enclosed with automatic reset integral thermal overload protection, designed to handle up to 104°F maximum constant ambient temperature.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before propeller unit-heater installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install propeller unit heaters level and plumb.

B. Install propeller unit heaters to comply with NFPA 90A.

C. Suspend propeller unit heaters from structure with all-thread hanger rods with vibration isolators. Hanger rods and attachments to structure are specified in other Division 23 sections.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Unless otherwise indicated, install union, control valve, strainer and ball valve on supply-water connection and union, calibrated balancing valve and ball valve on return-water connection of unit heater.

3.4 FIELD QUALITY CONTROL

A. Perform field tests and inspections as required by the manufacturer. Provide test reports.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 82 50

SECTION 23 89 00 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCES

A. ANSI/NFPA 70 — National Electrical Code.

B. ANSI C84.1 — Voltage Tolerances for North America.

C. IEC 68 Part 2-3 — Basic Environmental Testing Procedures Part 2: Tests — Damp Heat.

D. IEC 146.1 — Semiconductor Converters — General Requirements and Line Commutated Converters Part 1-1: Specifications of Basic Requirements.

E. IEC 664 — Insulation Coordination for Equipment Within Low-Voltage Systems.

F. IEC 447 — Man-Machine Interface Actuating Principles.

G. IEC 439 Part 1 — Low Voltage Switchgear and Control Gear Assemblies.

H. IEC 947 — Low Voltage Switchgear and Control Gear Components.

I. IEC 364 — Electrical Installation of Buildings.

J. IEC 204/NFPA 79 — Electrical Equipment of Industrial Machines/Industrial Machinery.

K. IEC 106 — Guide for Specifying Environmental Conditions for Equipment Performance Rating.

L. IEC 529 — Degrees of Protection Provided by Enclosure.

M. IEC 1000 — Electromagnetic Compatibility.

N. IEC 721 — Classification of Environmental Conditions.

O. IEC 255-8 — Overload Relays.

P. IEC 801-2,-3,-4,-5 — Immunity Tests.

Q. NEMA ICS 6 — Industrial Control and Systems Enclosures.

R. NEMA ICS, Part 4 — Overload Relays.

S. NEMA 250 — Enclosures for Electrical Equipment.

T. NEMA ICS 2-321 — Electrical Interlocks.

U. NEMA ICS7 — Industrial Control and Systems Adjustable Speed Drives.

V. NEMA ICS 7.1 — Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives.

W. UL 50 — UL Standard for Safety Enclosures for Electrical Equipment.

X. UL 98 — UL Standard for Disconnect Switches.

Y. UL 507 — UL Standard for Safety Electric Fans.

Z. UL 508 — UL Standard for Safety Industrial Control Equipment.

AA. UL 508C — UL Standard for Safety Power Conversion Equipment.

BB. UL 991 — UL Standard for Safety Tests for Safety Related Controls employing Solid-State Devices.

CC. OSHA 1910.95 — AC Drive Controller Acoustical Noise.

DD. Conforming to National Safe Transmit Association and International Safe Transmit Association Test for Packages Weighing 100 lbs. or Over.

1.3 SUMMARY

A. This section provides specification requirements for adjustable frequency drives and variable speed drives, herein referred to as AC Drives, for use with NEMA B, design AC motors.

B. The AC Drive manufacturer shall furnish, field test, adjust, and certify all installed AC Drives for satisfactory operation.

C. Any exceptions/deviations to this specification shall be indicated in writing and submitted with the quotation.

1.4 SUBMITTALS

A. Submittal packages including drawings shall be furnished for Engineers approval prior to factory assembly of the AC Drives. These packages shall consist of elementary power and control wiring diagrams on one drawing and enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall dimensions and weights shown, conduit entrance locations. Standard catalog specification sheets showing voltage, horsepower and maximum current ratings shall be furnished as part of the submittal package.

1.5 QUALITY ASSURANCE

A. The manufacturer of the AC Drive shall be a certified ISO 9002 facility.

B. The AC Drive and all associated optional equipment shall be UL Listed according to UL 508 C Power Conversion Equipment. As verification, a UL label shall be attached on the inside nameplate of the combination enclosure.

C. The AC Drive shall be designed, constructed, and tested in accordance with NEMA, NEC, and IEC standards.

D. Every power converter shall be tested with an AC induction motor while loaded and temperature cycled within an environment chamber at 40 <C (104 <F).

E. All pilot devices shall be industrial rated and tested to verify proper operation.

1.6 COORDINATION

A. Coordinate layout and installation of Adjustable frequency drives with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and

required clearances for equipment access doors and panels.

B. Coordinate features of Adjustable frequency drives, installed units, and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each drive and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.7 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. Spare Fuses: Furnish one spare for every five installed, but not less than one set of three of each type and rating.

2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. ABB Power Distribution, Inc.
2. Eaton.
3. Square D.
4. Danfoss.

B. Alternate control techniques other than pulse width modulated (PWM) are not acceptable.

2.2 GENERAL DESCRIPTION

A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage, as defined in the following sections.

B. The input power section shall utilize a full wave bridge design incorporating diode rectifiers. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. This power section shall be insensitive to phase rotation of the AC line.

C. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall utilize intelligent power modules (IPMs), as required by the current rating of the motor.

2.3 CONSTRUCTION

A. The AC Drive power converter shall be enclosed in a Type 1, or Type 12K enclosure with top and bottom conduit knockouts with a circuit breaker disconnect, industrial rated operator controls, user terminal strip connections and bypass controls (if required).

B. The enclosure shall provide dedicated user terminals for power and control device connection.

C. Provisions shall be included for locking the disconnect in the OFF position with a padlock.

D. All enclosure and heatsink fans shall be front accessible and not require the removal of the AC drive power converter.

2.4 MOTOR DATA

A. The AC Drive shall be sized to operate the following AC motor:

1. Motor horsepower.
2. Motor full load amperes.
3. Motor rpm will be 1800 at 60 Hz.
4. Motor voltage will be 208, 230, or 460 as indicated on the drawings
5. Motor service factor will be 1.15.
6. NEMA MG1 Part 31.

2.5 APPLICATION DATA

A. The AC Drive shall be sized to operate a Variable Torque load.

B. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 60 Hz.

2.6 ENVIRONMENTAL RATINGS

A. The AC Drive shall meet IEC 664-1 and NEMA ICS 1 Standards.

B. The AC Drive shall be designed to operate in an ambient temperature from 0 <C to 40 <C (32 <F to 104 <F).

C. The storage temperature range shall be -25 <C to 65 <C (-13 <F to 149 <F).

D. The maximum relative humidity shall be 95% at 40 <C (104 <F), non-condensing.

E. The AC Drive shall be rated to operate at altitudes less than or equal to 3,300 ft (1000 m). For altitudes above 3,300 ft (1,000 m), derate the AC Drive by 1% for every 330 ft (100 m).

F. The AC Drive shall meet the IEC 721-3-3-3M3 operational vibration specification.

2.7 RATINGS

A. The AC Drive shall be designed to operate from an input voltage of 460 VAC (") 10%, 230 VAC (") 10%, 208 VAC (") 10%.

B. The AC Drive shall operate from an input frequency range of 60 (") 5%.

C. The displacement power factor shall not be less than 0.98 lagging under any speed or load condition.

D. The efficiency of the AC Drive at 100% speed and load shall not be less than 97%.

E. The variable torque rated AC Drive over current capacity shall be not less than 110% for 1 minute.

F. The output carrier frequency of the AC Drive shall be programmable at 0.5, 1,2, 4, or 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.

2.8 PROTECTION

A. Upon power-up, the AC Drive shall automatically test for valid operation of memory, loss of analog reference input, loss of communication, DC-to-DC power supply, control power and pre-charge circuit.

B. Shaft grounding rings shall be incorporated into motors 10HP and higher to prevent electrically induced bearing damage when VFDs are utilized on larger pump and fan motors. Coordinate work with drive and equipment manufacturers.

C. The enclosure shall provide a fully-coordinated 22 kAIC rating marked on the enclosure nameplate. Short circuit coordination to UL508C Power Conversion Equipment and NEMA ICS 7.1.

D. The AC Drive shall be protected against short circuits, between output phases and to ground.

E. The AC Drive shall have a minimum AC undervoltage power loss ride-through of 200 milliseconds.

F. The AC drive shall have a programmable ride through function, which will allow the logic to maintain control for a minimum of one second (60 cycles) without faulting.

G. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide up to 6 programmable restart attempts. The time delay before restart attempts will be 30 seconds.

H. Upon loss of the analog process follower reference signal, the AC Drive shall be programmable to display a fault.

I. The AC Drive shall have a solid-state overload that is listed as a UL 508 C overload protective device and meets IEC 947.

J. The output frequency shall be software enabled to fold back when the motor is overloaded.

K. There shall be one skip frequency range that can be programmed to a bandwidth of ±2.5 Hz.

L. Provide phase loss protection at the motor with the application of an appropriate relay so that overloads trip during the loss of a single phase to the motor.

2.9 ADJUSTMENTS AND CONFIGURATIONS

A. The AC Drive will be factory programmed to operate all specified optional devices.

B. The acceleration and deceleration ramp times shall be adjustable from 0.05 to 999.9 seconds.

C. The memory shall retain and record run status and fault type of the past 8 faults.

D. The software shall have a Energy Economy function that, when selected, will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.

2.10 KEYPAD DISPLAY INTERFACE

A. The keypad display interface shall offer the modification of AC Drive adjustments via a touch keypad. All electrical values, configuration parameters, I/O assignments, application and activity function access, faults, local control, and adjustment storage, and diagnostics shall be in plain English. There will be a standard selection of 4 additional languages built-in to the operating software as standard.

B. The display will be a high resolution, LCD back-lit screen.

C. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency, and motor voltage shall be listed on the drive identification portion of the LCD display.

D. The keypad display shall consist of programmable function keys that allow both operating

commands and programming options to be preset by the operator. A hardware selector switch shall allow the terminal keypad to be locked out from unauthorized personnel.

2.11 OPERATOR CONTROLS

A. The control power for the digital inputs and outputs shall be 24 VDC.

B. The internal power supply shall incorporate automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current limited and will not be damaged if shorted.

C. Pull-apart terminal strips shall be used on all logic and analog signal connections in the power converter.

D. Two voltage-free relay output contacts will be provided. One of the contacts will indicate AC Drive fault status. The other contact shall indicate a drive run status.

E. The combination enclosure shall have the following dedicated operator controls::

1. Hand-Off-Auto switch and Start-Stop push button
2. Manual Speed Potentiometer
3. AFC-Off-Bypass switch
4. Test-Normal Selector switch
5. Power On (red) LED indicator
6. Drive Run (green) LED indicator
7. Drive Fault (yellow) LED indicator
8. Auto Mode (yellow) or Bypass Run (yellow) LED indicator.

F. The combination enclosure shall include a 120 VAC smoke purge relay option (if required). A user-supplied 120 VAC signal shall be sequenced in accordance with local fire protection codes and will switch the AC drive to 60 Hz operation for maximum fan motor speed. If drive bypass is supplied, the smoke purge relay will isolate the AC Drive and run the fan motor at full speed on bypass.

G. The combination enclosure shall include terminal point connection for fire/freeze stat interlock, to prevent drive or bypass operation.

2.12 DRIVE ISOLATION AND BYPASS CONTACTORS.

A. The AC Drive shall include mechanically and electrically interlocked isolation and bypass contactors complete with Class 20 thermal overload relay, circuit breaker disconnect, control circuit transformer, AFC/OFF/BYPASS switch and TEST/NORMAL selector switch.

B. The operator shall have full control of the bypass starter by operation of the AFC/OFF/BYPASS selector switch.

C. In the AUTOMATIC mode of operation the bypass contactors shall be sequenced by the 110-volt rated auto start contact provided by the user.

D. The isolation contactor for the bypass shall be sequenced to provide motor isolation during a drive ready state of operation.

E. A TEST/NORMAL selector switch shall provide test operation of the power converter while operating the motor in bypass.

2.13 HARMONIC MITIGATION

A. Provide 5 percent line reactors. The line reactors shall be mounted inside the drive enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive Adjustable frequency drives for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before drive installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each drive to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, drive, and load.

B. Select rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.

B. The AC Drive manufacturer shall provide a factory certified technical representative to inspect the contractor's installation, test and start-up the AC Drive(s) furnished under this specification. The start-up service shall be quoted as a separate line item.

3.4 IDENTIFICATION

A. Identify Adjustable frequency drives, components, and control wiring according to standard practice.

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 16 Sections.

B. Ground equipment.

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.

3.6 STARTUP SERVICE

A. Start-up service shall be provided by the equipment manufacturer's authorized representative and shall include complete testing of all controls and unit operation. The agency responsible for start-up shall provide copies of this data are to the owner.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

C. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 CLEANING

A. Clean Adjustable frequency drives internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning..

3.9 TRAINING

A. An on-site training course of 1/2 training days shall be provided by a representative of the AC Drive manufacturer to plant and/or maintenance personnel as an option.

3.10 DOCUMENTATION

A. The AC Drive manufacturer shall supply a comprehensive 8-1/2" x 11" bound instruction/installation manual that includes wiring diagrams, layout diagrams, and outline dimensions. This manual must be 3-hole punched for insertion in a shop manual supplied by the installing contractor.

END OF SECTION 23 89 00

SECTION 26 00 10 – BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division-1:

1. Submittals.
2. Coordination Drawings.
3. Record documents.
4. Maintenance manuals.
5. Rough-ins.
6. Electrical installations.
7. Cutting and patching.

1.2 SUBMITTALS

A. Follow the procedures specified in Division 1.

B. Submittals must be provided with all catalog information identified indicating all options to be provided as part of the product. Any submittal not containing this information will be rejected.

C. Provide the following shop drawings in booklet form:

1. Light fixtures cuts shall be submitted all at one (1) time in a booklet form.
2. Panelboards, disconnect switches, manual motor starters, combination motor starters / disconnect switches, and contactors shall be submitted all at one (1) time in a booklet form. All equipment shall be of one manufacturer.
3. Wire devices shall be submitted all at one (1) time in a booklet form and be from one (1) manufacturer.
4. Occupancy sensors shall be submitted all at one (1) time in a booklet form and be from one (1) manufacturer whether connected to a lighting control system or provided with power packs, unless noted otherwise.

1.3 PRODUCT REVIEWS AND SUBSTITUTIONS

A. Refer to Division 1 for substitutions requirements under this contract. Division 1 requirements supersede requirements listed elsewhere.

B. No Manufacturer's products will be reviewed as an equivalent to the specified products unless submitted by a Bidding Contractor for review ten (10) calendar days prior to bid due date. No products will be reviewed after that time. Product review requests must be submitted in accordance with Division 1 and Section 26 00 10. An addendum will be issued to all Bidding Contractors listing any Manufacturers whose products have been added to the Contract Documents as equivalents to the specified products.

C. No substitutions will be reviewed by the Engineer after the Bid Due Date unless specifically requested by the Owner or Architect in writing with an associated credit with the substitution.

1.4 SHOP DRAWINGS

A. Refer to the Conditions of the Contract (General and Supplementary) and Division-1 for submittal definitions, requirements, and procedures.

B. Where submittals include multiple items, a bill of material (not including quantity) shall be provided at the front of the shop drawing. The bill of material shall include product identification, manufacturer and model number.

C. Submittal of Shop Drawings, Product Data, and Samples will be reviewed only when submitted by the Prime Contractor. Submittals from sub-Contractors and material suppliers directly to the Architect/Engineer will not be reviewed. No equipment/materials shall be installed until the Shop Drawings have been stamped with "No Exceptions Taken" or "Make Corrections Noted" by the Architect/Engineer.

D. Submit Shop Drawings as listed in each specification section. Following is a list of shop drawings to assist the contractor; however, the contractor shall supply all shop drawings as listed in each individual section whether listed below or not.

1. Power and Lighting Panelboards.
2. Disconnect Switches.
3. Individually-Mounted Circuit Breakers.
4. Combination Motor Starter/Disconnect Switches.
5. Fuses.
6. Contactors.
7. Thermal Overload Switches.
8. Wiring Devices and Wall Plates.
9. Surface Raceway.
10. Dimmer Switches.
11. All Lighting Fixtures (submit in booklet form and with detail drawings where required).
12. Occupancy Sensors and associated layout drawings.
13. Fire Alarm Equipment and associated wiring diagrams, and layout drawings. Duct Detectors.
14. Fire Stopping Material.

E. When preparing submittals and any required final programming, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

F. Submittal Plans: Submittal plans **MUST** be provided with only the system being presented. Plans not submitted that have not be cleaned of extraneous systems (i.e. a low voltage system being installed on the power drawing, showing all the power and other low voltage systems), will be grounds for immediate rejection without review.

1.5 PRODUCT OBSOLESCENCE

A. In all cases, the most current iteration of the specified product shall be submitted. Where the specified product is no longer manufactured, the contractor shall submit an equivalent product with the same or better specifications. Where specific manufacturers are specified, the contractor shall supply from the same manufacturer the recommended replacement; however, under no circumstances shall the replacement product be deficient in any aspect to the specified product.

B. In the submittal for the product, the Contractor shall provide a signed letter clearly indicating the reason for the replacement product, and confirmation that the replacement product meets or exceeds all of the specified product's specifications to the best of the Contractor's knowledge.

C. The replacement product shall be provided at no additional cost to the owner, and shall not constitute any extension to the project schedule.

D. These requirements shall be inclusive to requirements listed elsewhere in the specifications, and shall not void any other requirements.

1.6 INSPECTIONS

A. The Contractor shall provide certificates of approval, in triplicate, for service equipment, building rough wiring, and building finished wiring.

B. Inspection certificates shall be submitted to the Engineer within 30 days after the inspections are made. Contractor shall use an independent NEC Certified Inspection Agency as the approved agency. Contractor must verify that the Certified Inspection Agency is approved by the local municipality and the Owner to inspect electrical installations in the project locality. All inspection certificates must be received before final payment can be made.

C. Refer to General Conditions for additional information.

1.7 MANUFACTURER'S REQUIREMENTS

A. All material shall be new, of the best respective kinds, manufactured by the company or companies mentioned and shall be of domestic manufacture unless specified otherwise.

B. All equipment, material or apparatus of any one system must be the product of one Manufacturer, or system tested products.

C. Manufacturers not listed in the Contract Documents must submit to the Engineer via a Bidding Contractor all product information per Division 1 requirements.

1.8 NAMEPLATE DATA

A. Each item of power operated equipment shall be provided with a permanent operational data nameplate on indicating Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance, and similar essential data. Nameplates shall be located in an accessible location.

1.9 FAMILIARITY WITH PROPOSED WORK

A. All Contracts are with the understanding that the Contractor, prior to submission of his bid, acquainted himself with the requirements of the Drawings and Specifications, including “Conditions of the Contract,” conditions of the site, its terrain, soil conditions, all other requirements of the Contract, and that he obtained all information necessary for completion of the work on or before the date specified for receiving of bids.

B. In all cases where a device or part of the equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation.

C. “Existing” information does not necessarily represent “as-built” conditions. The Contractor shall verify all existing conditions. If discrepancies are found the Contractor shall notify the Architect/Engineer for a resolution before proceeding.

1.10 DEFINITIONS

A. The terms “The Contractor” or “This Contractor” mentioned in these Specifications refers to the Electrical Contractor responsible for the work and equipment included in these Specifications.

B. The term Sub-Contractor refers to any reference to, or letting of work contained in these Specifications to any Sub-Contractor or Manufacturer by the Prime Contractor. This does not relieve the Prime Contractor of his responsibility for all work, material and equipment in this Specification.

C. The term “Provide,” when used separately, shall mean to “Furnish and Install.”

D. The term “Furnish,” when used separately, shall mean to obtain and deliver on the job for installation by other trades.

E. The term “Install,” when used separately, shall mean to mount in place, connect and make operable.

1.11 INTENT OF THE DRAWINGS AND SPECIFICATIONS

A. The Drawings which accompany the Specifications are for the purposes of illustrating the character and extent of the work, and are subject to such modifications by Architect/Engineer as may be found either necessary or advisable before ordering the prosecution of the work. The Contractor shall conform to and abide by whatever Supplementary Drawings and explanations which may be furnished by the Architect/Engineer for the purpose of illustrating the work. The Architect/Engineer shall decide as to the meaning or intention of any portion of the Specifications and Drawings.

B. Where the work is shown in complete detail on only half or a portion of a Drawing, or there is an indication of

continuation, the remainder being shown in outline, the work drawn out in detail shall be understood to apply to other like portions of the structure. All work that may be called for in the Specifications and not shown on the Drawings, or shown on the Drawings and not called for in the Specifications, shall be executed and furnished by the Contractor as described in both.

C. Should any incidental work or materials be required, but not set forth in the Specifications or Drawings, either directly or indirectly, but which is necessary to fulfill the intent thereof, the Contractor is to understand same to be implied and required, and he shall perform all such work and furnish all such materials as fully as if they were particularly delineated or described, without additional cost to Owner. This shall include all materials, devices, methods peculiar to the machinery, equipment, apparatus, or systems as described herein.

1.12 EQUIPMENT ENCLOSURE RATINGS

A. Electrical equipment installed within the building shall carry a NEMA rating 1 or higher if indicated in the specifications or on the drawings.

B. Electrical equipment installed outside the building, or in environmentally wet locations shall carry a NEMA rating 3R or higher if indicated in the specifications or on the drawings.

C. Electrical equipment installed in harsh environments (i.e. natatoriums, greenhouses, etc.) shall carry a NEMA rating 4X, and be manufactured from stainless steel.

D. Where specifications and drawings conflict (i.e. drawings indicated NEMA 3R, but specifications indicate NEMA 1), the higher rating shall be provided at no additional cost to the project.

1.13 WIRING LAYOUTS

A. Should it become necessary to rearrange any of the circuit or feeder wiring, approval to do so shall first be obtained from the Engineer. The Contractor will be supplied with a spare set of Drawings on which all such approved changes shall be noted. Upon completion of all work under this Contract, these Drawings shall be returned to the Architect/Engineer, who will issue a receipt for same.

1.14 FIELD MEASUREMENTS

A. Before ordering any materials or doing any work, Contractor shall verify all measurements at the building site, and shall be responsible for correctness of same. At no time shall the Contractor scale Drawings for the purpose of installation.

B. No extra compensation will be allowed on account of differences between actual dimensions and those indicated on the Drawings. Any difference which may be found shall be submitted to the Architect/Engineer for consideration before proceeding with the work.

1.15 COORDINATION

A. The Contractor shall cooperate with the other Contractors and shall arrange to eliminate conflicts with the equipment and work of the Contractors.

B. The Contractor shall be responsible for coordinating all electrical devices/equipment with the casework before rough-in. Any conflicts with casework and electrical devices/equipment shall be brought to the attention of the Architect/Engineer before rough-in. Any electrical device/equipment installed in conflict with casework shall be removed and reinstalled at the Contractor's expense.

C. The Contractor shall be responsible to coordinate all electrical conduits which are installed for rooftop equipment. Where the equipment can be fed from within the equipment curb, the contractor shall utilize this space. Where the equipment must be fed from the exterior, the contractor shall furnish and install a roof curb designed for conduit penetrations.

1.16 CHASES AND OPENINGS

A. The Contractor shall determine, in advance, the locations and sizes of all chases and openings necessary for the proper installation of his work and have same provided during construction. Any chase or opening not made during construction, due to the Contractor's failure to determine same in advance, shall be done by the Contractor at his own expense. Any unnecessary cutting shall be repaired to match the original conditions of the area disturbed at the Contractor's expense.

1.17 AIR PLENUMS

A. The Contractor shall use a conduit system or approved plenum rated wiring for all wiring located above ceilings.

1.18 RECORD DOCUMENTS

A. Refer to Division-1 for requirements. The following requirements supplement the requirements of Division-1.

B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned from column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; work performed via Change Orders; concealed control system devices.

C. Mark Specifications to indicate changes by addendum or Change Orders; actual equipment and materials used.

D. All new underground utilities shall be marked and dimensioned on site plan as-built drawings.

1.19 OPERATION AND MAINTENANCE DATA

A. Refer to Division-1 for requirements.

B. Contractor shall provide Operation and Maintenance data listed in individual section in addition to requirements listed in Division 1.

1.20 WARRANTIES

A. Division 1 warranties shall be considered minimum warranties. Any warranties listed in the individual sections that are longer than Division 1 warranties shall be honored.

B. Refer to individual sections for warranty requirements beyond those as specified in Division 1.

1.21 TEST AND ADJUST

A. All systems installed under this Contract shall be tested and adjusted to insure that all equipment and systems meet or exceed the specified requirements.

1.22 PHASE LOAD BALANCE

A. A reasonable balance shall be secured on the phases of all main distribution feeders and bus bars.

B. Following installation and with the system in operation, the Electrical Contractor shall check the balance and rearrange connections so that the ampacity on any of the two single-phase phases of the main bus shall not vary more than 10% of each other.

1.23 PAINTING

A. Refer to the Division-1 for general requirements.

B. The Contractor shall be responsible for all touch up painting on this project for electrical work.

C. The Contractor shall be responsible for painting of all conduits that is installed after general painting has been completed.

1.24 CLEANING

A. Refer to Division-1 Section, “Project Closeout” or “Final Cleaning” for general requirements for final cleaning.

B. The Contractor shall keep the building free of rubbish and material during the course of construction insofar as the work under this Contract is concerned.

C. Upon completion of the project, the Contractor shall remove all rubbish, surplus equipment and shipping labels and have all areas broom clean. The Contractor shall thoroughly clean all fixtures, and other electrical equipment, leaving same in first-class working condition.

1.25 INSTRUCTION OF OWNER'S PERSONNEL

A. The Contractor shall provide instruction of the owner’s personnel as outlined in Division 1. The following requirements shall be included in addition to Division 1 requirements.

B. The Contractor shall provide the services of competent personnel and/or Manufacturer trained personnel to instruct employees designated by the Owner in the proper operation, care and maintenance of the equipment and system installed under the Contract.

C. A letter of certification itemizing the equipment, system, instructor, and bearing signatures of the employees instructed shall be delivered to the Engineer and the Owner upon completion of the project. The letter of certification shall note the number of hours spent in explanation and actual operation of system with maintenance personnel.

1.26 DELIVERY AND STORAGE OF MATERIALS

A. Refer to the Division-1 for delivery and storage of materials requirements.

B. The Contractor shall provide for, or secure use of, suitable-dry storage space for the safe delivery and storage of his materials. The Contractor shall be responsible for providing their own storage trailers on site. The use of Owner’s inside-building storage will not be permitted, unless noted otherwise.

1.27 PROTECTION OF EQUIPMENT AND MATERIALS

A. Responsibility for care and protection of electrical work rests with the Contractor until it has been tested and accepted by the Owner. After delivery, before and after installation, protect equipment and materials against theft, injury, or damage in all cases.

B. Protect equipment outlets, and pipe openings with temporary plugs, caps, or burlap. Electrical conduit openings shall be covered with capped bushing or fiber disks and bushings.

C. The contractor shall be responsible to protect all existing electrical or communications equipment to remain from construction dirt and debris, whether created from this contractor or another contractor. The contractor shall determine the method needed to protect each piece of equipment to remain. Should existing equipment be damaged during demolition it will be the responsibility of the contractor to provide necessary repairs or replacement of the damaged equipment.

1.28 SCAFFOLDING AND HOISTING

A. The Contractor shall provide all lumber and other material required for the erection of all staging, scaffolding, shoring, protective platforms, railings and ladders. Scaffolding shall be removed at the completion of the work.

B. The Contractor shall protect any flooring that is to remain. The Contractor shall inspect the flooring before the scaffolding is installed and report any damage that exists before the stat of the construction. The

Contractor shall be responsible to repair any damage to the flooring after the scaffolding is removed to the acceptance of the owner at no additional cost to the owner.

1.29 PERMITS AND FEES

A. Unless noted otherwise, all general permits, certificates, tests, and inspection fees required for the work provided under this contract shall be paid by the Contractor. Refer to General Conditions for additional information.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment Specifications in Divisions-2 through -25 for rough-in requirements.

3.2 EXTERIOR AND INTERIOR EXCAVATION

A. Prior to any digging outside and inside the building, the Contractor shall provide Ground Penetrating Radar (GPR) to ensure there are no utilities in the area of excavation. Should any utilities be found, the contractor shall provide information to the engineer, architect and owner and propose alternate locations for the excavation. If the contractor neglects to perform the GPR prior to excavation and destroys any underground utilities, it shall be the responsibility of the contractor to repair the utilities to the engineer, architect and owner's satisfaction without any additional cost to the owner.

3.3 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division-1. In addition to the requirements specified in Division-1, the following requirements apply. The Contractor shall be responsible for providing all cutting and patching required to perform his work unless noted otherwise.

B. Perform cutting, fitting, and patching of electrical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Architect, uncover and restore work to provide for Architect observation of concealed work.

C. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Unless noted otherwise, where equipment is being provided on existing roofing systems, the contractor shall provide all roof patching where he penetrates the roof. The roof patching must be performed by an authorized vendor of the roofing system, maintaining all existing roofing warranties. The Contractor must

contract with the owner's existing roofing vendor.

3.4 PROTECTION OF INSTALLED WORK

A. During construction activities, including cutting and patching operations, protect adjacent installations.

B. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.5 ELECTRICAL INSTALLATION

A. Coordinate electrical equipment and material installation with other building components. Verify all dimensions by field measurements. If no dimensions are given, Contractor shall verify with Architect or Engineer before starting work. At no time shall the Contractor scale Drawings for the purpose of locating items.

B. Provide for chases, slots, and openings in other building components to allow for electrical installations. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

C. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

D. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible, or to meet current local, national and ADA codes.

E. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

F. Install systems, materials, and equipment to conform with submittal data, including Coordination Drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.

G. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

H. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

I. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.6 ELECTRICAL REQUIREMENTS FOR EQUIPMENT INSTALLATION

A. Conduit and power wiring of required size and voltage, from a panelboard or similar source, shall be furnished and installed by this Contractor, to the equipment furnished by another Contractor. A junction box or means of disconnect (as required) shall be furnished and installed at the equipment by this Contractor meeting the National Electric Code.

B. Unless noted otherwise, a full complement of electrical control components, required for the intended use and/or operation of specified equipment, including variable frequency controllers, speed controllers and/or other control devices required, whether integral or remote, shall be furnished by the Contractor furnishing the equipment. These control devices as well as power wiring (where required) through these devices shall be installed by this Contractor.

3.7 CONTROL WIRING FOR EQUIPMENT INSTALLED BY ANOTHER CONTRACTOR

A. This Contractor shall be responsible for providing all required control wiring, (except HVAC system control wiring) for any equipment provided by another Contractor which shall include, but not be limited to, motorized backboards, screens, partitions, curtains, motor operated doors, etc, unless noted otherwise.

B. The Contractor shall provide all boxes and conduit required for any equipment provided by another Contractor. Control wiring shall also include any wiring of motion or occupancy sensors for doors, curtains, etc.

C. Coordinate all required work for a complete and functional system with the Contractor supplying the equipment. Make all required connections.

3.8 TEMPORARY ELECTRIC/TELEPHONE (add other architect requirements)

A. Refer to Division-1, “General Conditions.”

B. Lighting: Provide temporary lighting in accordance with OSHA, (5-footcandles) with local switching to fulfill security requirements and provide illumination for construction operations and traffic conditions.

1. Lamps and Light Fixtures: Provide general service lamps. Provide guard cages or tempered glass enclosures, where exposed to breakage. Provide exterior fixtures where exposed to moisture.

3.9 ELECTRICAL DEMOLITION

A. The Electrical Contractor shall be responsible for all electrical demolition.

B. The Contractor shall be responsible for disconnecting and removing from the site all conduit, wiring, light fixtures, devices, panelboards, disconnect switches, fire alarm. The Owner shall tag or notify the Contractor as to any devices, equipment or systems which they wish to salvage before start of each phase of construction. See “Salvage” paragraph 3.14 for additional information.

C. The Electrical Contractor shall review all demolition drawings, including from other trades, and remove from the site all power wiring and associated electrical equipment, including, but not limited to wire, conduit, boxes, disconnecting means, supports, etc. feeding equipment that is being removed by other trades. This includes within the building, on the roof, attached to the building, and on the site.

D. Where fastened equipment is removed, the contractor shall be responsible to remove the associated lags or bolts that fastened the equipment down. Grind lags or bolts to below exiting surface and patch surface to match existing condition.

3.10 SALVAGE

A. The Owner reserves the right to salvage any electrical equipment prior to the start of each phase of construction.

END OF SECTION 26 00 10

SECTION 26 05 00 – COMMON REQUIREMENTS – ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes materials and methods that are common to various Electrical Systems.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Fireproofing
2. Access Doors

1.3 COORDINATION

A. Arrange for conduit spaces, chases and openings in building structure during progress of construction to allow for electrical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are construction as applicable.

C. Coordinate requirements for access panels and doors for electrical items requiring access that are concealed behind finished surfaces.

PART 2 - PRODUCTS

2.1 FIRESTOPPING

A. The Contractor shall be responsible for providing permanent, UL approved firestopping systems for all penetrations through fire rated floor or fire rated wall assemblies. For areas that will require future access for the installation of additional cables, repair, or retrofit, the firestopping system shall consist of re-usable intumescent pillows or putty. All firestopping shall meet the requirements of ASTM E-814 and UL 1479.

1. Subject to compliance with project requirements, firestopping materials may be provided by one of the following Manufacturers.

a. Specified Technologies Inc. (STI) Somerville, NJ (800) 992-1180
b. Tremco, Beechwood, OH (800) 321-7906
c. 3M, St. Paul, MN (800) 328-1687

2. Submit for review the following product data.

a. Product data sheets.
b. UL System Drawings for each firestopping application.
c. Manufacturer’s Certificates of Conformance for their products.

PART 3 - EXECUTION

3.1 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment Specifications in Divisions-2 through -25 for rough-in requirements.

3.2 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

A. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

B. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

3.3 FIRESTOPPING

A. Comply with manufacturer's written instructions for install fire stopping. When mechanical system is used, set securely in place in accessible locations.

B. Firestopping shall be installed in all fire rated walls. Review all drawings, including architectural, and site conditions to determine where fire rated walls are located.

END OF SECTION 26 05 00

SECTION 26 05 19 – WIRES AND CABLES – 600V AND BELOW

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. The extent of the wire and cable work is indicated by Drawings and by requirements or other sections of the Specifications for cables used for power, lighting, signal, control and related system rated 600 volts or less. See below paragraph 2.4 B. for permitted use of Type MC Cables on this project.

1.2 CODES AND STANDARDS

A. NEC Compliance: Comply with applicable requirements of NEC for construction and installation of wires/cables and connectors.

B. UL Compliance: Comply with UL Stds 83 and 486A, B and C. Provide wiring/cabling and connector products which are UL-listed and labeled consistent with their uses.

C. ICEA Compliance: Insulated Cable Engineers Association Inc., Standard WC-5-86.

D. IEEE Compliance: Institute of Electrical and Electronic Engineers, Standard 82-83.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all wires and cables of sizes indicated on the Drawings and suitable for the temperature, conditions and location where installed. Install all wire in raceway.

2.2 CONDUCTOR MATERIAL

A. Use copper conductors of 98% conductivity and rated at 600V for all wires and cables, unless otherwise noted.

2.3 INSULATION

A. No conductors smaller than No. 12 AWG shall be used unless noted elsewhere. All wires No. 8 AWG or larger shall be stranded. Wire sizes No. 12 and No. 10 AWG. shall be solid (stranded wire used for No. 12 AND 10 will not be permitted unless otherwise noted).

B. All copper conductors shall be provided with type THHN/THWN insulation, unless noted otherwise

C. Each circuit shall be provided with a dedicated neutral wire. Sharing of neutral wire for multiple circuits shall not be permitted, unless otherwise noted.

2.4 CABLES

A. Provide the following in NEC approved locations and project applications where indicated.

B. Type MC Cable: Provide Metal Clad Cable wiring using two No. 12 AWG with separate copper ground wire (unless noted otherwise). Where AC (armored cable without separate neutral) is installed, Contractor will be required to remove cable and reinstall with approved cable type at no additional cost to the owner. Metal Clad cable may be used on this project only as follows:

1. For lighting and receptacle branch circuits from panel to device(s) or light fixture(s).

2. Connection to motors (2 feet maximum);
3. Fishing existing walls.
4. Branch circuits in stud walls.
5. Mechanical equipment/miscellaneous branch circuits inside of the building (less than 50amps) where condition warrants.

C. Where MC cables are run in parallel (i.e. down corridors), the Contractor shall bundle the cables and zip tie them together.

D. The Contractor shall bear all costs related for removing MC cable not pre-approved. Support and secure type MC cable at intervals not exceeding 6'-0". In addition, type MC cable must be supported within 12" of every fitting, junction box or outlet box that the cable enters. **MC Cables are not permitted to be installed in exposed areas of the building. All wiring shall be installed in conduit in exposed areas of the building.**

E. All other wiring shall be installed in conduit as specified in section 26 05 33, unless approved otherwise by the Engineer prior to installation.

F. All feeder wiring shall be run in conduit.

2.5 CONNECTORS FOR CONDUCTORS

A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

PART 3 - EXECUTION

3.1 WIRES AND CABLES

A. General: Install electrical cables, wires, and connectors in compliance with NEC. Coordinate cable installation with other work. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

B. Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.

C. While installing cables, care shall be taken to protect outer coating. If outer coating is damaged, contractor shall remove and reinstall cables.

D. Conceal all cable in finished spaces. Install exposed cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours, where possible. Keep conductor splices to minimum.

E. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. Use splice and tap connectors which are compatible with conductor material.

F. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal. Provide wire ties and neatly train and rack wires in all boxes, panels, and other areas as required.

G. Tighten electrical connectors and terminals, including screws and bolts, in accordance with Manufacturer's published torque tightening values. Where Manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

H. Each branch circuit shall be provided with a dedicated neutral wire, unless noted otherwise.

3.2 FIELD QUALITY CONTROL

A. Prior to energizing, cables, 600 Volt or less and size no. 3 or larger, shall be meggered using an industry-approved "megger with a minimum of 500 Volt internal generating voltage. All inspection, cleaning and testing procedures shall be in compliance with the recommendations and standards outlined in the "maintenance testing specifications for electrical power distribution equipment and systems", latest edition, published by International Electrical Testing Association (NETA). Insulation resistance test values shall be no less than 250 megaohms. A typewritten report of all readings shall be prepared and submitted.

B. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

D. Color-Coding for Phase Identification:

1. Color-code secondary service, feeder, and branch circuit conductors with factory-applied color as follows:

Phase	120/208 Volts	120/240 Volts	277/480 Volts
A	Black	Black	Brown
B	Red	Orange (High-Leg)	Orange
C	Blue	Blue	Yellow
Traveler	Yellow	Yellow	Yellow w/ “T” tag
Neutral	White	White	Gray
Ground	Green	Green	Green w/ Yellow stripe

2. Switch legs shall include an additional “S” tag.
3. Provide visible colored taped as listed above at all termination points for No. 8 and larger wires.

END OF SECTION 26 05 19

SECTION 26 05 26 – GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of electrical grounding and bonding work is indicated by Drawings and Schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.

B. Type of electrical grounding and bonding work specified in this section includes the following:

1. Solidly grounded.

1.2 CODES AND STANDARDS

A. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.

B. UL Compliance: Comply with applicable requirements of UL 467, 486A, and 869, pertaining to grounding and bonding of systems, circuits and equipment. Provide grounding and bonding products which are UL-listed and labeled for their intended usage.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. General: Except as otherwise indicated, provide electrical grounding and bonding system assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Installer's option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

B. Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding system connections that match power supply wiring materials and are sizes according to NEC.

C. Bonding Plates, connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp Manufacturers for indicated applications.

D. Ground Electrodes and Plates:

1. Grounding Electrodes: Solid copper, 5/8" diameter by 10 feet.
2. Grounding Electrodes: Steel with copper welded exterior, 3/4" diameter by 10 feet.

E. Electrical Grounding connection Accessories: Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories Manufacturers for type service indicated.

F. Direct Burial Compression Grounding System similar to Panduit’s Structural Ground “Direct Burial Compression Grounding System” shall also be acceptable where exothermic connections are specified. Direct Burial System shall meet IEEE Standard 837-2002. System shall also meet UL 467. Contractor shall be responsible for providing all Grounding plates, connectors, cables Hydraulic crimping tool, etc for a complete system. All other Direct Burial Grounding system manufacturers shall be submitted for approval prior to bidding.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Architect/Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEM

A. General: Install electrical grounding and bonding system as indicated, in accordance with Manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.

B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.

C. Branch Circuits: Install a minimum 12 AWG ground wire in each 20A circuit and conduit run and to connect to each device. Size larger circuit ground wires as per NEC Table 250-122.

D. Exothermically weld grounding conductors to underground grounding electrodes.

E. Ground electrical service system neutral at service entrance equipment to grounding electrodes per NEC Article 250. Grounding conductor shall be 4/0 copper, unless otherwise noted.

F. Direct burial compression grounding system similar to T&B and Panduit shall also be acceptable. System shall meet IEEE Standard 837-2002. System shall meet UL.

G. Ground each separately-derived system neutral to separate grounding electrode.

H. Connect together system neutral, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.

I. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug, bus, or bushing.

J. Connect grounding electrode conductors to copper electrodes as per N.E.C., building steel and 1" diameter, or greater, metallic cold water pipe using a suitably sized ground clamp. Provide grounding electrode connection to concrete slab rebar to meet NEC. Provide 4/0 copper conductor for all connections.

K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with Manufacturer's published torque tightening values for connectors and bolts. Where Manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

L. Route grounding connections and conductors to ground and protective devices in shortest and straightest paths as possible to minimize transient voltage rises.

M. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory-applied protective coatings have been destroyed, which are subjected to corrosive action.

N. Install clamp-on connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

O. Provide ground wire connection to all electrical boxes and wiring devices.

P. Provide #6 AWG copper ground conductor connection to all cable trays. Cable tray grounding shall be continuous.

Q. Provide minimum #6 AWG ground connection from transformer to building steel. Provide larger conductor as required per NEC and drawings.

R. Bond service ground conduit to grounding conductor if conduit is metallic.

S. The contractor shall be responsible to provide grounding connection on gas piping where an appliance or mechanical piece of equipment has gas and electric circuit run to it. The ground conductor size shall be the same size as the electrical branch circuit run to the appliance or equipment to meet the NEC. article 250.

3.3 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, take appropriate action to reduce resistance to 25 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.

B. The contractor shall be responsible to test grounding system on site and turnover documentation to owner that grounding system is compliant with specifications.

C. Contractor shall coordinate with local inspector to provide tests as required.

END OF SECTION 26 05 26

SECTION 26 05 29 – SUPPORTING DEVICES

PART 1 - GENERAL

1.1 CODES AND STANDARDS

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical supporting devices.

B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

C. UL Compliance: Provide electrical components and devices which are UL-listed and labeled.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one (1) type of device fulfills indicated requirements, selection is Installer's option.

2.2 SUPPORTS

A. Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

B. Clevis Hangers: For supporting up to 2" rigid metal conduit; galvanized steel; with 2" diameter hole for round steel rod; approximately 54 pounds per 100 units.

C. Riser Clamps: For supporting up to 5" rigid metal conduit; black steel; with 2 bolts and nuts, and 4" ears; approximately 510 pounds per 100 units.

D. Reducing Couplings: Steel rod reducing coupling, 2" x 5/8", black steel; approximately 16 pounds per 100 units.

E. C-Clamps: Black malleable iron; 2"rod size; approximately 70 pounds per 100 units.

F. I-Beam Clamps: Black steel, 1-1/4" x 3/16" stock; 3/8" cross bolt; flanges width 2"; approximately 52 pounds per 100 units.

G. One-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; approximately 7 pounds per 100 units.

H. Two-Hole Conduit Straps: For supporting 3/4" rigid metal conduit; galvanized steel; 3/4" strap width; and 2-1/8" between center of screw holes.

I. Hexagon Nuts: For 2" rod size; galvanized steel; approximately 4 pounds per 100 units.

J. Round Steel Rod: Black steel; 2" diameter; approximately 67 pounds per 100 feet.

K. Offset conduit clamps: For supporting 2" rigid metal conduit; black steel; approximately 200 pounds per 100 units.

2.3 ANCHORS

A. Provide anchors of types, sizes and materials indicated; and having the following construction features:

B. Lead Expansion Anchors: 2”; approximately 38 pounds per 100 units.

C. Toggle Bolts: Spring head; 3/16" x 4"; approximately 5 pounds per 100 units.

D. Manufacturers: Provide anchors of one of the following (for each type of anchor):

1. Ackerman Johnson Fastening Systems, Inc.
2. Ideal Industries, Inc.
3. Joslyn Manufacturing and Supply Co.
4. McGraw Edison Co.

2.4 SLEEVES AND SEALS

A. Provide sleeves and seals, including armored cable seals, of types, sizes, and materials indicated, with the following construction features:

B. Sleeve Seals: Provide sleeves for piping which penetrated foundation walls below grade, or exterior walls. Caulk between sleeve and pipe with non-toxic, UL-classified caulking material to ensure watertight seal.

C. Wall and Floor Seals: Provide watertight wall and floor seals, or types and sizes indicated; suitable for sealing around conduit, pipe, of tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

D. Fire-Rated Walls and Floors: At all locations where conduits, cables, or ducts penetrate a fire-rated wall or floor, a special fire-retardant caulking compound or other approved device as specified in section 26 05 00 shall be used.

2.5 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for 2” rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.6 U-CHANNEL STRUT SYSTEMS

A. Provide U-channel strut system for supporting equipment supplied under this contract, 12-ga hot-dip galvanized steel, or types and sizes indicated; construct with 9/16” diameter holes, 8” on center on top surface, with standard green finish, and with the fittings which mate and match with U-channel. The Contractor is responsible to size and install strut to meet properly support its intended load.

B. Auxiliary Steel Supports: Provide all required auxiliary steel to install any equipment supplied under this contract. The design and gauge of steel used shall be as required by the manufacturer's specifications. The Contractor is responsible to size and install auxiliary steel to properly support its intended load.

C. Drop Cords: At Drop Cord locations provide miscellaneous threaded rod, unistrut, steel plates, etc. to vertically and laterally support Drop Cord. Where drop cord is located on ceilings provide proper support to prevent movement and damage to ceiling tile.

D. Manufacturers: Provide U-channel strut systems of one of the following (for each type system):

1. Allied Tube and Conduit Corp.
2. Midland-Ross Corp.
3. OZ/Gedney Div; General Signal Corp.
4. Power-Strut Div; Van Huffel Tube Corp.
5. Unistrut Div; GTE Products Corp.

PART 3 - EXECUTION

3.1 GENERAL

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices. Comply with installation requirements of NECA and NEC pertaining to supporting devices.

B. Coordinate with other mechanical and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Where supports or anchors are installed after the spray on insulation and/or firestopping is installed, patch the spray on insulation and/or firestopping to match surrounding area.

END OF SECTION 26 05 29

SECTION 26 05 33 – RACEWAYS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The extent of the raceway and work required by this section is indicated by Drawings and requirements of other sections of this Specification.

B. Provide metal and nonmetallic conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated on plans. Where types and grades are not indicated, provide proper selection determined by installer to fulfill wiring requirements and comply with applicable portions of NEC for raceways.

C. It is the intent of these Specifications and Drawings that all feeder wiring be run in a continuous conduit system. Type MC cables are permitted for lighting and power, branch circuits above ceilings and in stud walls, fishing existing walls, and connection to equipment/motors (2 feet max). In areas of exposed structure all wiring shall be run in conduit. At all locations where MC cable cannot be fished in an existing wall, surface (non metallic or metallic as specified) raceway shall be used. Finish of raceway shall be verified with the Architect before ordering. Surface raceway shall be screwed into the surface being installed at both ends and every 24” minimum along raceway. All surface raceway shall be run parallel and perpendicular to wall surfaces and run to blend in with surrounding equipment.

D. Refer to section 26 05 19 for acceptable uses of MC cables.

1.2. CODES AND STANDARDS

A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.

B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; provide products and components which have been UL-listed and labeled.

C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of raceway systems.

PART 2 - PRODUCTS

2.1. CONDUITS

A. Rigid Steel Conduit: Provide rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1 and UL 6. Provide zinc-coating fused to inside and outside walls.

B. Rigid Aluminum Conduit: Provide rigid aluminum, threaded type conforming to ANSI and UL standards.

C. Intermediate Steel Conduit: Provide rigid intermediate grade (IMC) hot-dip galvanized threaded conforming to FS WW-C-581 and UL 1242.

D. Electrical Metallic Tubing (EMT): FSW-C-563, ANSI C80.3, and UL 797.

E. Liquid-Tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit; construct of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC).

F. Flexible Metal Conduit: FS WW-C-566 and UL 1. Formed from continuous length of spirally wound, interlocked zinc-coated strip steel.

G. PVC Heavy Wall Conduit: Schedule 40, 90C, UL-rated, constructed of polyvinyl chloride and conforming to NEMA TC-2, for direct burial, UL-listed and in conformity with NEC Article 347. PVC conduit may only be installed above finished grade, where specifically indicated on the drawings or within the specifications.

H. PVC Light Wall Conduit shall not be acceptable under any circumstances. PVC Heavy Wall conduit shall be used when encased in concrete.

I. No other type of conduit shall be used, unless otherwise noted, or prior approval granted by the engineer.

2.2. CONDUIT FITTINGS

A. Flexible Metal Conduit Fittings: Provide conduit fittings for use with flexible steel conduit of threadless hinged clamp type.

B. Straight Terminal Connectors: Contractor shall provide one-piece body, with female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

C. 45-Deg or 90-Deg Terminal Angle Connectors: Two-piece body construction with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and male threaded end provided with locknut.

D. Rigid Metal Conduit Fittings: Cast-malleable-iron, galvanized or cadmium plated, conforming to FS W-F-408. Use Type 1 fittings for raintight connections, Type 2 fittings for concrete tight connections, and Type 3 fittings for other miscellaneous connections.

E. Rigid Aluminum Conduit Fittings: Provide cast-aluminum conduit fittings and mounting hardware conforming to ANSI and UL standards of types required for the application.

F. Liquid-Tight Flexible Metal Conduit Fittings: FS W-F-406, Type 1, Class 3, Style G. Provide cadmium-plated, malleable-iron fittings with compression type steel ferrule and neoprene gasket sealing rings, with insulated, or non-insulated throat.

G. EMT Fittings: All couplings and connectors shall be of the compression type.

H. PVC Heavy Wall Conduit and Tubing Fittings: Mate and match to conduit or tubing type and material.

I. Conduit and Tubing Accessories: Provide conduit, tubing and duct accessories of types, sizes, and materials, complying with Manufacturers' published product information, which mate and match conduit and tubing.

J. Conduit Bodies: Provide galvanized cast-metal conduit bodies of types, shapes, and sizes as required to fulfill job requirements and NEC requirements. Construct conduit bodies with threaded-conduit entrance ends, removable covers, either cast or galvanized steel, and corrosion-resistant screws.

K. All raceway conduit and fittings above a ceiling shall be plenum rated.

L. Press type fittings may <u>not</u> be used unless specifically specified to be acceptable elsewhere in the specifications or on the drawings.

2.3. WIREWAYS

A. General: Provide electrical wireways of types, grades, sizes, and number of channels for each type of service as indicated. Provide complete assembly of raceway including, but not limited to, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other components and accessories as required for complete system.

B. Lay-In Wireways: Provide lay-in wireways with hinged covers, in accordance with UL 870 and with components UL-listed, including lengths, connectors and fittings. Design units to allow fastening hinged cover closed without use of parts other than standard lengths, fittings and connectors. Construct units to be capable of sealing cover in closed position with sealing wire. Provide wireways with knockouts.

C. Connectors: Provide wireway connectors suitable for "lay-in" conductors, with connector covers permanently attached that removal is not necessary to utilize the lay-in feature.

D. Finish: Protect sheet metal parts with rust inhibiting coating and baked enamel finish. Plate finish hardware to prevent corrosion. Protect screws installed toward inside of wireway with spring nuts to prevent wire insulation damage.

E. Raintight Troughs: Construct in accordance with UL 870, with components UL listed.

F. Construction: 16-ga galvanized sheet metal parts for 4" x 4" to 6" x 6" sections, and 14-ga parts for 8" x 8" and larger sections. Provide knockouts only in bottom of troughs, with suitable adapters to facilitate or tear during installation, or would compromise raintight capability of the trough. Do not use cover screws that will protrude into the trough area and damage wire insulation.

G. Finish: Provide 14-ga and 16-ga galvanized sheet metal parts with corrosion-resistant phosphate primer and baked enamel finish. Plate hardware to prevent corrosion.

PART 3 - EXECUTION

3.1. GENERAL

A. Low voltage wiring in walls must be run in conduit system rated for 600V, as specified above. the use of flexible innerduct material in walls shall not be acceptable. In new construction, conduits shall be rigid of appropriate type for the installation.

B. Unless noted otherwise, all conduit shall be installed concealed in walls, under slabs, or above ceilings.

C. Type MC cables shall be permitted only as noted.

D. Unless noted otherwise, raceways and cables shall be installed near the structure and be supported independently from the structure. Support systems for other building systems (i.e. ductwork, HVAC equipment, system piping, ceiling supports, etc.) shall not be used to support conduits and cables. When routed from light fixtures and other system connections, raceways and cables shall be routed directly vertical to structure and across. Drop wire supports shall not be used on any ceiling support wires under any circumstances.

E. Use PVC Schedule 40 conduit where feeders and service conductors are embedded in concrete, masonry, or earth, and use rigid galvanized steel elbows with large sweep elbows wherever turns are needed **(do not use PVC elbows)**. Where PVC conduit is installed below finished floor level within the building pad, contractor shall transition to an approved type of above ground conduit within the floor slab, at the elbow. Where PVC conduit is used exterior to the building under finished grade, contractor shall transition to galvanized rigid steel conduit at the elbow up, and continue using galvanized rigid steel along the riser to above finished grade.

F. PVC Schedule 40 conduit may be run in CMU wall cavities when originating from below finished grade and terminating at a recessed box no higher than 48” above finished floor or grade. For all other installations within wall cavities, PVC conduit shall not be used.

G. Use rigid aluminum conduit where installed exposed outdoors.

H. Use EMT conduit in mechanical equipment rooms, electrical equipment rooms, penthouses, crawl spaces, walls, and areas above ceiling.

I. Use flexible metal conduit in moveable partitions and from outlet boxes to recessed lighting fixtures, and final 24" of connection to motors, or control items subject to movement or vibration, and in cells of precast concrete panels. Conduit size shall be increased as required to fit wiring per NEC.

J. Use liquid-tight flexible metal conduit in mechanical spaces. Conduit size shall be increased as required to fit wiring per NEC.

K. Cut conduits straight, properly ream, and cut threads for heavy wall conduit deep and clean.

L. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameters.

M. Size conduits to meet NEC, except no conduit shall be smaller than 3/4" on this project.

N. Fasten conduit terminations in sheet metal enclosures by two locknuts, and terminate with bushing. Install locknuts inside and outside enclosure. **Metallic insulating conduit bushings shall be used on all power conduits.** Split bushings shall not be acceptable.

O. Conduits are not to cross pipe shafts or ventilating duct openings.

P. Keep conduits a minimum distance of 6" from parallel runs of hot water pipes or other sources of heat. Wherever possible, install horizontal raceway runs above water and steam piping.

Q. Support riser conduit at each floor level with clamp hangers.

R. Use of running threads at conduit joints and terminations is prohibited.

S. Where required, use 3-piece union or split coupling.

T. Complete installation of electrical raceways before starting installation of cables/wires within raceways.

U. For concrete floors-on-grade, install PVC Schedule 40 conduits under concrete slabs.

V. Install underground conduits minimum of 24" below finished grade.

W. Install conduits so as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.

X. Above requirements for exposed conduits also apply to conduits installed in space above hung ceilings, and in crawl spaces.

Y. Conduits shall not be installed against roof deck. Allow minimum 3" space between top conduit and roof deck for the possible penetration of roof nails to protrude without damaging conduit.

Z. In finished spaces without ceilings (i.e. gymnasiums, natatoriums, etc.), conduits shall be installed as high as possible, while meeting other requirements within these specifications. Conduits along bottom cord of open joists shall not be acceptable. Where conduits need to be installed along bottom of joists or beams, they shall be installed against walls.

AA. Provide fish wire or pull string in all spare conduits.

BB. Cap all spare conduits installed for future use.

CC. Install surface metal raceways in corners or walls or conceal as much as possible.

DD. There shall be no more than three (3) 20A branch circuits installed in a single 3/4" conduit. Each circuit shall be provided with a dedicated neutral wire. Sharing of neutral wire for multiple circuits will not be permitted.

EE. At locations where conduits are installed after painting is done, the contractor shall be responsible to go back and paint conduit and boxes same color to match.

FF. Metallic and non-metallic raceway shall be mechanically fastened to surfaces at intervals as recommended by the manufacturer. Under no circumstances shall glue, two-sided tape, or other type of adhesive be the only means of attachment.

GG. For exterior wall or foundation penetrations, seal around conduits/sleeves and annular space between sleeve and conduits to limit water migration.

1. Select seal material to fit the installation location, and ensures no degradation of the sealing material over time due to environmental conditions including, but not limited to continuous ground or rain water, solar impact, temperature changes, freezing, etc. Where exposed, sealing compound shall match adjacent surfaces in texture and color.

HH. Where conduits are installed to pass through existing walls, the wall shall be cored to allow the conduit to be installed through the wall, and fire calk installed around the conduit. Should MC cable be installed through a wall, an EMT sleeve of sufficient size to fit all of the MC cables shall be installed through a core in the wall, fire calk installed around the sleeve, and fire putty installed around the MC cable. Should the contractor break out blocks, or cut an opening in the wall, not using a properly sized hole saw, he shall provide an appropriately sized lintel to maintain structural integrity of the wall, patch the wall by toothing in new block, new drywall sheet, or other means matching the wall material, and provide fire calk around the conduit or sleeve in the opening.

3.2. CONDUITS IN CONCRETE SLABS

A. Conduits installed in concrete slabs will not be permitted. PVC conduits shall be installed under concrete slabs in stone base minimum 4” below to top of conduit.

B. Conduits installed in elevated slabs will not be permitted. Conduits shall be installed in ceiling plenum spaces below elevated slabs.

3.3. EXPOSED CONDUITS

A. Install exposed conduits and extensions from concealed conduit systems neatly, parallel with, or at right angles to walls of building.

B. Install exposed conduit work as not to interfere with ceiling inserts, lights, or ventilation ducts or outlets.

C. Support exposed conduits by use of hangers, clamps, or clips. Support conduits on each side of bends and on spacing not to exceed following: Up to 1": 6'-0"; 1-1/4" and over: 8'-0".

D. Run conduits for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.

E. Cap all spare and active conduits stubbed up from the floor with secure PVC caps. Caps used for active conduits shall be notched to accommodate the quantity and size of cables installed in each conduit.

F. Exposed conduits shall be run along walls and at 3” from roof deck. – deck screws, gym, etc.

G. Where exposed conduits are installed outside of spaces labeled as electrical or mechanical, they shall be prepped and painted with appropriate products to match adjacent surfaces, unless specifically stated, in writing, by the architect/engineer/owner that they may remain unfinished.

3.4. NON-METALLIC CONDUITS

A. Make solvent cemented joints in accordance with recommendations of Manufacturer.

B. Install PVC conduits in accordance with NEC and in compliance with local utility practices. Provide expansion joints as required by Manufacturer and NEC.

3.5. CONDUIT FITTINGS

A. Construct locknuts for securing conduit to metal enclosure with sharp edges for digging into metal, and ridged outside circumference for proper fastening.

B. Bushings for terminating conduits smaller than 1-1/4" are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation.

C. Install insulated type bushings for terminating conduits 1-1/4" and larger.

D. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.

E. Bushing of standard or insulated type to have screw type grounding terminal.

F. Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split couplings, and plugs to be specifically designed for their particular application.

3.6. RACEWAYS AND WIREWAYS

A. Avoid use of dissimilar metals through system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.

B. Install expansion fittings in all raceways/wireways wherever structural expansion joints are crossed.

C. Make changes in direction to raceway/wireway run with proper fittings, supplied by raceway Manufacturer. No field bends of raceway/wireway sections will be permitted.

D. Properly support and anchor raceways/wireways for their entire length by structural materials. Raceways are not to span any space unsupported.

E. Use boxes as supplied by Manufacturer wherever junction, pull or device boxes are required. Standard electrical "handy" boxes, etc., shall not be permitted for use with surface installations.

END OF SECTION 26 05 33

SECTION 26 05 35 – ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK

A. The extent of electrical box and associated fittings work is indicated by Drawings and Schedules.

1.2. CODES AND STANDARDS

A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring boxes and fittings.

B. UL Compliance: Comply with UL Std No.'s 50, 514-series and 886. Provide electrical boxes and fittings which are UL-listed and labeled.

C. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and Pub 250.

PART 2 - PRODUCTS

2.1. FABRICATED MATERIALS

A. Outlet Boxes: Provide galvanized coated flat-rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated (or as required), suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding. Flush boxes must be mounted flush with finished wall surface.

B. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code - compliance option.

C. Device Boxes: Provide galvanized coated flat-rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes, including box depths as indicated (or as required), suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cables clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Flush boxes must be mounted flush with finished wall plate.

D. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's codes-compliance option.

E. Surface-Mounted Device and Outlet Boxes: Provide a minimum depth galvanized-coated steel box where indicated on the Drawings without pre-punched knockouts.

F. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, including face plate gaskets and corrosion-resistant plugs and fasteners.

G. Junction and Pull Boxes: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers. Provide handles on covers over 4 square feet.

H. Where surface or recessed boxes are indicated to be blank or with wire leads for future use, they shall be provided with blank covers per Division 26 “Wiring Devices”.

I. Under no circumstances shall low voltage rings be used on the project. All outlet boxes used for low voltage system including, but not limited to tele/data, controls, A/V wiring, etc. shall be fully enclosed device boxes as specified above.

PART 3 - INSTALLATION

3.1. GENERAL

A. Install electrical boxes and fittings as indicated, in accordance with Manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices to fulfill project requirements.

B. When installed in stud walls (wood or steel), electrical boxes shall be installed in walls, supported from both sides, bridged between studs, the use of cantilevered supports shall be unacceptable.

C. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

D. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.

E. Provide knockout closures to cap unused knockout holes where blanks have been removed.

F. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.

G. Wherever possible, avoid installing boxes back-to-back in walls. Provide not less than 6" (150mm) separation or separate stud spaces.

H. Position recessed outlet boxes accurately to allow for surface finish thickness.

I. Where devises are shown at casework, contractor shall coordinate exact location and height with casework to ensure usability of devices.

J. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.

K. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

L. Provide electrical connections for installed boxes.

M. Subsequent to installation of boxes, protect boxes from construction debris and damage.

N. Ground electrical boxes properly upon completion of installation work and demonstrate compliance with requirements. Ground electrical box and wiring device.

END OF SECTION 26 05 35

SECTION 26 05 53 – ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 CODES AND STANDARDS

A. UL Compliance: Comply with UL Std 969.

B. NEC and NEMA Compliances: Comply with NEC and NEMA WC-1 and WC-2.

C. ANSI Compliance: Comply with ANSI Std A13.1.

PART 2 - PRODUCTS

2.1 GENERAL

A. Except as otherwise indicated, provide Manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is installer's option, but provide single selection for each application.

2.2 UNDERGROUND-TYPE PLASTIC LINE MARKER

A. Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

1. Provide line marker with detectable metallic core for installation above primary power, secondary power and communications service ductbanks.
2. Provide standard plastic line markers for all other installations.

2.3 CABLE/CONDUCTOR IDENTIFICATION BANDS

A. Provide Manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

2.4 SELF-ADHESIVE PLASTIC SIGNS

A. Provide Manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application areas and adequate for visibility, with proper wording for each application (e.g., “EXHAUST FAN FED FROM PANEL PD1”).

B. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

2.5 ENGRAVED PLASTIC-LAMINATE SIGNS

A. Provide engraving stock melamine plastic laminate with black face and white core plies (letter color), complying with FS L-P-387, in sizes and thicknesses indicated. Engrave laminate with engraver's standard letter style of sizes and wording indicated, and punch for mechanical fastening except where adhesive mounting is necessary because of substrates.

B. Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.6 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by Manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

2.7 MANUFACTURER

A. Provide electrical identification products of one of the following (for each type marker):

1. Ideal Industries, Inc.
2. LEM Products, Inc.
3. Markal Company
4. National Band and Tag Co.

PART 3 - EXECUTION

3.1 GENERAL

A. Install electrical identification products as indicated, in accordance with Manufacturer's written instructions, and requirements of NEC.

3.2 COORDINATION

A. Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

3.3 REGULATIONS

A. Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.4 UNDERGROUND CABLE IDENTIFICATION

A. During backfilling/topsoiling of each exterior underground electrical, signal or communication cable, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.

B. Install line marker for every buried cable, regardless of whether direct-buried or protected in conduit.

3.5 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable-conductor identification where wires of communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, Contract Documents, and similar previously established identification for project's electrical work.

B. Install engraved plastic-laminate tags on new power cables in all manholes and in pullboxes to identify over current device number. Use tie wraps to attach tag to cables. The nameplate shall bear the following information: Building served; voltage, cable size, class of insulation, phase designation.

3.6 DANGER SIGNS

A. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about project.

B. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.

C. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.

3.7 MEDIUM VOLTAGE WARNING SIGNS

A. Contractor shall provide warning signs as described in 225.70 of the most current version of NEC. Signs shall include, but not be limited to:

1. “DANGER – HIGH VOLTAGE” signs located at the following areas:

a. All entrances to electrical equipment vault, room, area or enclosure.
b. On all panel doors of medium and high voltage switchgear and unit substations that provide access to live parts over 600 volts.
c. At points of access to conductors on all conduit and cable systems over 600 volts.
d. On all cables trays containing conductors over 600 volts with the maximum spacing of warning notices not to exceed 10 feet.

2. Provide warning signs at medium and high voltage fuse cabinets warning operators not to replace fuses while the circuit is energized.
3. A permanent, legible, single-line diagram of the switchgear shall be laminated and provided in a readily visible location within sight of the switchgear. Coordinate location with owner.

3.8 ARC FLASH LABELS

A. Provide arc flash labels on equipment per NEC and NFPA. Labels shall be placed in a prominent position that is clearly visible before access to a dangerous area is reached. This includes the front of devices similar to disconnect switches, motor starters, switchboards, etc. and just inside the front cover of panelboards. The labels shall be of sufficient durability to withstand the environment involved.

B. Provide signs for each unit of the following categories of electrical work.

1. Panelboards, electrical cabinets and enclosures.
2. Combination starter / disconnect switches.
3. Disconnect switches.

3.9 SERVICE ENTRANCE FAULT CURRENT LABELS

A. Provide label at service entrance equipment (switchboard, distribution panelboard, etc.) The label shall be of sufficient durability to withstand the environment involved. The label shall indicate the following information per NEC and NFPA:

1. Nominal system voltage
2. Maximum available fault current
3. Clearing time of service overcurrent protective device(s) based on the available fault current.
4. The date the label was applied.

B. The contractor shall coordinate with the utility to determine the available fault current at the point of utility connection, and calculate the maximum available fault current available at the service entrance. All calculations shall be made available at the service entrance gear, as well as being located in the Operations and Maintenance manuals.

3.10 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), White lettering in Black field. Provide text matching terminology and numbering of the Contract Documents and shop drawings. Each listed piece of equipment below shall have a sign that has the following: 1. Equipment Name, 2. Where the equipment is fed from. Example: PANEL “PD1" (FED FROM PANEL DPD).

B. Provide signs for each unit of the following categories of electrical work.

1. Panelboards, electrical cabinets and enclosures.
2. Combination starter/disconnect switches.
3. Disconnect switches.
4. Motor control Centers

C. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.

3.11 DIRECTORIES

A. Provide typed circuit directory cards in all panelboards (both breaker and fuse type) and low voltage lighting control panels indicating the room number or area, and the item or items controlled by each circuit. Provide typed circuit directory cards for all “Existing” panelboards and low voltage lighting control panels where the Contractor has added, deleted or moved circuits with in an “Existing” panelboard.

1. Contractor shall trace existing circuits within existing panelboards and low voltage lighting control panels to properly identify all circuits within the panelboards and low voltage lighting control panels.

B. Switchboards, unit substations, motor control centers and switchgear shall be provided with plastic-laminate tags similar to those specified in under “Equipment/System Identification”. The tags shall indicate what the circuit feeds and the location of the device.

C. Directories shall use actual room numbers to indicate locations of all devices, including, but not limited to receptacles, lighting, mechanical equipment, etc. When preparing schedule, use a room number schedule generated by the architect and/or the owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, request, in writing, a schedule to reflect the proper room numbers.

D. Provide sufficient information to meet requirements of Article 408 of the National Electric Code.

3.12 ADDITIONAL FUSE LABELING

A. At the exterior enclosure of all fused switches, provide additional labeling designating fuse sizes, types and quantity.

3.13 EMERGENCY POWER SOURCE NOTIFICATION

A. Provide a sign at the main service location indicating type and location of emergency power source in accordance with the requirements of Section 700-8 of the National Electrical Code.

3.14 FIRE PUMP IDENTIFICATION

A. Provide marking on switchboard showing fire pump tap stating switchboard section is used for a “Fire Pump Tap”. Label location on front of switchboard as to where the fire pump is located within the building.

3.15 RECEPTACLE CIRCUIT IDENTIFICATION

A. At each receptacle, identify panelboard and circuit number from which receptacle is served. Use machine printed, pressure sensitive, abrasion resistant label tape on backs of the wall plate and durable wire markers or tags within outlet boxes.

END OF SECTION 26 05 53

SECTION 26 26 16 – PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Lighting and appliance branch circuit panelboards.
2. Distribution panelboards.

1.2 DEFINITIONS

A. GFCI: Ground fault circuit interrupter.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and Manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short circuit current rating of panelboards and overcurrent protective devices.
d. UL listing for series rating of installed devices.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between Manufacturer installed and field installed wiring.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

A. 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.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company.

B. No Other Manufacturers Will Be Considered.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush and surface mounted cabinets. Refer to panel Schedules on Drawings to determine flush or surface. NEMA PB 1, Type 1 for interior locations and Type 3R for exterior locations, unless noted otherwise in the documents.

B. Front: See panelboard, Hinged Trim Covers

C. Finish: Manufacturer's standard enamel finish over corrosion resistant treatment or primer coat.

D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

E. Bus Material (Main, Neutral & Ground): Hard drawn copper, 98 percent conductivity.

F. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.

G. Equipment Ground Bus: Adequate for feeder and branch circuit equipment ground conductors; bonded to box.

H. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches. Provide when indicated on the panel Schedules.

I. Skirt for Surface Mounted Panelboards: Provide skirts with same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor. Skirts shall be provided for all surface mounted panels in all rooms with exception of rooms labeled on plans “Electric or Mechanical”.

J. Feed through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANELBOARD SHORT CIRCUIT RATING

A. Panelboards shall be fully rated to interrupt symmetrical short circuit current as indicated on the schedules. All breakers within panelboards shall be fully rated to the panel AIC rating. Series ratings of branch breakers or bus shall not be acceptable.

2.4 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: See Panelboard Hinged Trim Covers

2.5 DISTRIBUTION PANELBOARDS

A. Doors: Front mounted secured with latch and lock; keyed alike.

B. Main Overcurrent Protective Devices: Circuit breaker or Main Lugs Only. Refer to panel Schedule.

C. Branch Overcurrent Protective Devices: Bolt on circuit breakers.

D. Provide Branch Feeder Metering Devices. Refer to Power Riser Diagrams and Panel Schedules for catalog numbers, quantities and size of metering devices.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal Magnetic Circuit Breakers: Inverse time current element for low level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single pole configurations with 5mA trip sensitivity.

B. Molded Case Circuit Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air conditioning, and refrigerating equipment.

3. Ground Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time delay settings, push to test feature, and ground fault indicator.
4. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.

2.7 ARC ENERGY REDUCTION

A. For any circuit breaker rated for 1200A, or can be adjusted to 1200A or higher, an electronic circuit breaker must be used, and the following shall be provided:

1. Documentation shall be made available, at the switchboard, regarding the Arc Energy Reduction methodology.
2. The applicable breaker shall be provided with an energy-reducing maintenance switch setting with local status indicator.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: To test functions of solid state trip devices without removal from panelboard.

C. Provide top and bottom panel skirts for all surface mounted lighting and power panels.

2.9 HINGED TRIM COVERS

A. Provide Hinged Trim Panelboard covers for lighting and power panelboards. Entire Trim Hinged to one side of the box with a piano type hinge to access panel gutter space. Front door of panel shall be keyed to lock.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1

B. Mounting Heights: Top of trim 74 inches above finished floor, unless otherwise indicated.

C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Refer to Section 260553 for more information.

E. Install filler plates in unused spaces.

F. Provision for Future Circuits at Flush Panelboards: Stub four 1 inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub two 1 inch empty conduits below slab not on grade into suspended ceiling cavity.

G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Provide panel and circuit identification as outlined in Division 26 “Electrical Identification”.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to Manufacturers’ 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. Test continuity of each circuit.

B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load balancing circuit changes outside normal occupancy/working Schedule of the facility and at time directed. 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 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 PROTECTIVE SHIELDS

A. Provide metal protective shield(s) under all piping located within 3’-0” of the panelboard to defect a pipe leak away from the electrical equipment. Shield(s) shall be sized as required to cover the required pipe to prevent water from reaching the panelboard.

3.6 ADJUSTING

A. Set field adjustable switches and circuit breaker trip ranges.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 26 16

SECTION 26 27 26 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes receptacles, connectors, switches, and finish plates.

1.2 DEFINITIONS

A. GFCI: Ground fault circuit interrupter.

1.3 SUBMITTALS

A. Product Data: For each product specified.

B. Shop Drawings:

1. Legends for receptacles and switch plates, where indicated on the drawings.
2. Provide Occupancy Sensor catalog literature including performance specifications indicating compliance to the specifications.

C. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NEMA WD 1.

C. Comply with NFPA 70.

D. Compliance with Federal Specifications – indentified by the federal specifications mark (capital letters ‘F’ and ‘S’ each in a wing on either side of the UL Listing mark):

1. Receptacles and GFCI’s: Federal Specification number WC596.
2. Switches: Federal Specification number WS896.

1.5 COORDINATION

A. Receptacles for Owner Furnished Equipment, or Equipment furnished by other trades: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers

1. Hubbell HBL1221 Series.
2. Leviton 1221-2 Series.
3. Pass & Seymour PS20AC1 Series.
4. Arrow Hart (Cooper) AH1221 Series.

B. Description: NEMA WD 1, heavy duty industrial grade, binding screw type for back and side wiring, AC only snap switch with grounded mounting strap, and grounding terminal with green screw.

C. Toggle Color: As selected by Architect.

D. Types: Switch shall be single pole, double pole, three-way, or 4-way, as required by the drawings.

E. Voltage Rating: 120/277 volts, AC.

F. Current Rating: 20 amperes.

G. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded.

2.2 ANALOG 0-10V WALL DIMMERS

A. Manufacturers

1. Lutron Diva 0-10V Series Control.

a. For loads exceeding 8A, provide PP-DV power pack.

2. Hubbell Rocker Slide Dimmer.
3. Leviton Decora Slide Dimmer.
4. Pass & Seymour Radiant Paddle Slide Dimmer.

B. Description: Decora style rocker/paddle switch with 0-10V LED compatible slide dimmer.

C. Toggle Color: As selected by Architect.

D. Types: Single pole, or three-way as required by the drawings.

E. Voltage Rating: 120/277 volts, AC.

F. Current Rating: as required for load. If load exceeds dimmer rating, provide compatible power pack.

2.3 OCCUPANCY SENSORS

A. Manufacturers

1. Watt Stopper.
2. Pass & Seymour.
3. Sensor Switch.
4. Hubbell.
5. Greengate.
6. Leviton.
7. All occupancy sensors on project shall be from one (1) manufacturer.

B. Products

1. Listed products by application shall be Watt Stopper product numbers. Should the contractor choose to use an alternate listed manufacturer, they shall provide the sensor that meets the requirements of the specified sensors. Should an alternate manufacturer require additional sensors due to coverage patterns, they shall be provided at no additional cost to the owner.

a. Provide low (24) voltage ceiling mounted dual technology occupancy sensor DT-300 series with isolated relay in instructional spaces.
b. Provide line (120/277) voltage ceiling mounted dual technology occupancy sensor DT-355 in instructional spaces.

c. Provide low (24) voltage ceiling mounted ultrasonic occupancy sensor UT-300 series with isolated relay in restrooms, storage rooms and corridors. Provide coverage pattern to accommodate entire room.
d. Provide line (120/277) voltage ceiling mounted ultrasonic occupancy sensor UT-355 in restrooms, storage rooms and corridors.
e. Provide low (24) voltage ceiling mounted passive infrared occupancy sensor CI-300 series with isolated relay in offices and conference rooms. Provide coverage pattern to accommodate entire room.
f. Provide line (120/277) voltage ceiling mounted passive infrared occupancy sensor CI-355 in offices and conference rooms.
g. Provide, low (24) voltage high ceiling mounted passive infrared occupancy sensor HB300B series in high ceiling/structure spaces (gymnasiums, atriums, etc.). provide coverage pattern to accommodate entire space.
h. Provide, low (24) voltage low temperature / wet listed passive infrared occupancy sensor CB-100 series with isolated relay in refrigerated, exterior and unconditioned spaces. Provide coverage patter to accommodate entire area.
i. Provide, where indicated, dual (120/277) voltage passive infrared wall switch occupancy sensor PW-300.
j. Provide, where indicated, dual (120/277) voltage passive infrared 0-10V dimming wall switch occupancy sensor PW-311.
k. Provide a dual (120/277) voltage power packs, BZ-250 (programmed for manual on when connected with low voltage station) and relay packs compatible with sensors as required.
l. All sensors shall be set per manufacturer recommended time delay.

2. Wall switch sensors shall be capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet.
3. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180˚ coverage capability.
4. Wall switch products shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
5. Wall switch sensors shall have no leakage current to load, in manual or in Auto/Off mode for safety purposes and shall have voltage drop protection.
6. Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.
7. Vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Products utilizing a soft lens will not be considered.
8. Passive infrared sensors shall utilize Pulse Count Processing and Digital Signature Analysis to respond only to those signals caused by human motion.
9. Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
10. Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.
11. Dual technology sensors shall be either corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas.
12. Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
13. Ultrasonic sensors shall utilize Advanced Signal Processing to adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
14. Ultrasonic operating frequency shall be crystal controlled at 25 kHz within ± 0.005% tolerance, 32 kHz within ± 0.002% tolerance, or 40 kHz ± 0.002% tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
15. All sensors shall be capable of operating normally with electronic ballasts, PL lamp systems and rated motor loads.
16. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
17. When specified, sensors shall utilize SmartSet™ technology for automatically adjustable time delay and sensitivity settings.
18. All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
19. In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

20. All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
21. Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
22. All sensors shall have UL rated, 94V-0 plastic enclosures.

C. Circuit control hardware – CU

1. Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to externally mount through a 1/2" knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Control unit shall provide power to a minimum of two (2) sensors.
2. Relay Contacts shall have minimum ratings of:

   20A – 120 VAC Incandescent
   20A – 120 VAC Ballast
   20A – 277 VAC Ballast

3. Control wiring between sensors and controls units shall be Class II, 18-24 AWG, stranded U.L. Classified, PVC insulated or TEFLON jacketed cable suitable for use in plenums, where applicable.
4. Minimum acceptable wire gauge from the circuit control hardware relays shall be #12 AWG.
5. Input voltage shall be dual (120/277) rated.

2.4 RECEPTACLES

A. Duplex Convenience Receptacle

1. Manufacturers

   a. Hubbell HBL5362 Series.
   b. Leviton 5362 Series.
   c. Pass & Seymour PS5362 Series.
   d. Arrow Hart (Cooper) AH5362 Series.

2. Description: Heavy-Duty Federal Industrial Spec Grade with nylon face (smooth), brass strap, brass contacts for side and back wiring, and nylon base.
3. Provide with WR (weather resistant) label when installed in exterior applications per code.
4. Where indicated on the drawings, or per current version of NEC, provide the tamper resistant version with internal shutter system.
5. Color of receptacles shall be as selected by the Architect.
6. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded. Provide similar to Pass & Seymour “Plug Tail” type receptacles.

B. Tamper Resistant Duplex Convenience Receptacle

1. Manufacturers

   a. Hubbell HBL5362TR Series.
   b. Leviton 5362-SG Series.
   c. Pass & Seymour TR63 Series.
   d. Arrow Hart (Cooper) TR5362 Series.

2. Description: Heavy-Duty Federal Industrial Spec Grade tamper resistant with nylon face (smooth), brass strap, brass contacts for side and back wiring, and nylon base.
3. Provide with WR (weather resistant) label when installed in exterior applications per code.
4. Provide the tamper resistant with internal shutter system.
5. Color of receptacles shall be as selected by the Architect.

6. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded. Provide similar to Pass & Seymour “Plug Tail” type receptacles.

C. Tamper Resistant Duplex USB Charger Receptacle **(1 type A, 1 type C)**

1. Manufacturers

   a. Hubbell USB8300AC5 Series.
   b. Leviton T5833-HG Series.
   c. Pass & Seymour TR20HUSBAC6 Series.

2. Description: Hospital Grade tamper resistant with high-impact resistant thermo plastic construction.
3. Provide with WR (weather resistant) label when installed in exterior applications.
4. Provide the tamper resistant with internal shutter system.
5. Provide with two USB ports, (1) shall be type A, and the other shall be type C.
6. USB charging shall comply with USB BC1.2 battery charging and 3.0 power delivery specifications.
7. USB charging shall supply minimum 5 amp.
8. Color of receptacles shall be as selected by the Architect.
9. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded. Provide similar to Pass & Seymour "Plug Tail" type receptacles.

D. Tamper Resistant Duplex USB Charger Receptacle **(2-type A)**

1. Manufacturers

   a. Hubbell USB8300A5 Series.
   b. Leviton T5832-HG Series.
   c. Pass & Seymour TR8300HUSB Series.

2. Description: Hospital Grade tamper resistant with high-impact resistant thermo plastic construction.
3. Provide with WR (weather resistant) label when installed in exterior applications.
4. Provide the tamper resistant with internal shutter system.
5. Provide with two (2) USB type A ports.
6. USB charging shall comply with USB BC1.2 battery charging and 3.0 power delivery specifications.
7. USB charging shall supply minimum 5 amp.
8. Color of receptacles shall be as selected by the Architect.
9. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded. Provide similar to Pass & Seymour "Plug Tail" type receptacles.

E. Tamper Resistant Ground Fault Circuit Interrupter (GFCI) Receptacle

1. Manufacturers

   a. Hubbell GFTR20 Series.
   b. Leviton X7899 Series.
   c. Pass & Seymour 2095TR Series.
   d. Arrow Hart (Cooper) TRVGF20

2. Description: Federal Specification Grade tamper resistant with high-impact-resistant thermoplastic construction, brass contacts for side and back wiring and LED trip indicator light.
3. GFCI receptacles shall not be connected to protect downstream devices, unless noted otherwise on the drawings. Provide unit designed for installation in a 2-3/4" deep outlet box without adapter, grounding type, Class A, Group 1, per UL 943.
4. Device shall comply with Federal Specification WC596. Devices shall have protection so that if critical components are damaged and ground fault protection is lost, power to receptacle shall be disconnected.
5. Provide with WR (weather resistant) label when installed in exterior applications per code.

6. Provide tamper resistant with internal shutter system.
7. Prewired and plug-in devices shall be acceptable provided device matches specifications and plug-in devices are crimped and welded.

F. Weatherproof Receptacle

1. Consisting of a GFCI receptacle as specified above in an outlet enclosure that is UL listed for wet locations, and meet NEC and OSHA requirements while in use.

a. Exterior-mounted receptacles **installed in existing walls and on mechanical units** shall have a self-closing weatherproof (in use) cover similar to Pass & Seymour WIUC series. Exterior-mounted receptacles **installed in new walls** shall have a self-closing weatherproof (in use) and be mounted over a recessed box similar to Arlington Industries DSBVR1W series. Paint cover to match adjacent surface with appropriate type of paint. Coordinate color with Architect prior to ordering.

2.5 SPECIAL PURPOSE RECEPTACLES

A. Manufacturers

1. Hubbell.
2. Leviton.
3. Pass & Seymour.
4. Arrow Hart (Cooper).

B. Description: Polarized, grounding type

C. Device Body: Black nylon

D. Configuration: As required by the amperage and voltage of the equipment to be connected on the drawings.

E. Provide equipment cord and caps as required for equipment.

2.6 WIRING DEVICE ACCESSORIES

A. Wall Plates: Provide wall plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates.

B. Wall Plates: Provide 302 satin finished stainless steel wall plates throughout the building.

C. Provide galvanized steel wall plates in unfinished spaces.

2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber insulated, stranded copper conductors, with type SOW A jacket. Green insulated grounding conductor, and equipment rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable clamping jaws. Match cord and receptacle type for connection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

B. Verify all receptacle mounting heights before roughing in unless noted. If an outlet is installed in such a location as to be out of proper relation to beams, walls, or finish details of the building, its location shall be corrected by and at the expense of the Contractor under direction of the Architect/Engineer.

C. Install devices and assemblies plumb and secure only in electrical boxes which have been cleaned of excess building materials, dirt, and debris. Device to be secure tight against wall box and flush with wall plate.

D. Install switches on latch side of doorways.

E. Install wall plates when painting is complete.

F. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

G. Do not share neutral conductor on load side of dimmers.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Protect devices and assemblies during painting.

J. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

K. Analog Dimmers: Provide the required low and/or line voltage wiring shall be provided to control the fixture. Any and all additional accessories required, including power packs, shall be provided in their entirety.

L. Install Occupancy Sensors to meet the following requirements. Locations indicated on the plans are diagrammatical, and do not necessary represent the optimal placement of sensors.

1. Sensor is activated within half step into room.
2. If person walks past open door, but not into room, sensor does not activate.
3. Contractor shall be responsible to reposition any sensor where the above is not accurate.
4. Occupancy Sensors shall be provided with minimum 10’ additional wiring to allow repositioning of the sensor after the fact for poorly positioned sensors. Extra wire shall be coiled and supported adjacent to the power pack.

3.2 INSTALLATION TO MEET ACOUSTICAL PERFORMANCE

A. In order to reduce sound transmission through walls, when devices boxes are installed to serve both sides of the wall, they shall be installed in different stud cavities. Where boxes are found to be installed in the same stud cavity, feeding two different sides of the wall, they will be required to be removed and reinstalled at the contractor's expense.

3.3 IDENTIFICATION

A. The requirements listed below are in addition to the requirements listed in Division 26 “Electrical Identification”.

B. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

C. Receptacles: Identify panelboard and circuit number from which served. Use machine printed, pressure sensitive, abrasion resistant label tape on backside of the wallface plate and durable wire markers or tags within outlet boxes.

3.4 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.

C. Tighten electrical connectors and terminals according to manufacturers published torque tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.6 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

SECTION 26 28 13 – FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor control centers; and spare fuse cabinets.

1.2 SUBMITTALS

A. Product Data: Include dimensions and Manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.

1.3 QUALITY ASSURANCE

A. Source Limitations: Provide fuses from a single Manufacturer.

B. 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.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.4 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply Manufacturer's ambient temperature adjustment factors to fuse ratings.

1.5 COORDINATION

A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.

1. Fuses: Quantity equal to one (1) set for every five (5) installed sets, but not fewer than one set of three of each kind.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Industries, Inc.; Bussmann Div.
2. General Electric Co.; Wiring Devices Div.
3. Mersen (Ferraz Shawmut).
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Main Service: Class L, time delay (601 to 6000A) or Class J, time delay (0 to 600A).

B. Main Feeders: Class L, time delay (601 to 6000A) or Class J, time delay (0 to 600A).

C. Combination Starter/Disconnect Switches: Class RK5, time delay.

D. Disconnect Switches: Class RK5, time delay (30-600A).

E. Other Branch Circuits: Class RK5, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. The requirements listed below are in addition to the requirements listed in Division 26 “Electrical Identification”.

B. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

SECTION 26 28 16 – DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Disconnect switches.

B. Enclosures.

1.2 REFERENCES

A. FS W F 870 Fuseholders (For Enclosed Cartridge Fuses).

B. FS W S 865 Switch, Box, (Enclosed), Surface Mounted.

C. NEMA KS 1 Enclosed Switches.

1.3 SUBMITTALS

A. Submit product data under provisions of Section 26 00 10.

B. Include outline Drawings with dimensions, and equipment ratings for voltage, capacity, horsepower, and short circuit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D Company.

B. No Other Manufacturers will be considered.

2.2 HEAVY DUTY TYPE

A. All switches shall have switch blades which are visible when the switch is OFF and the cover is open.

B. Lugs shall be front removable and UL listed for 60°C or 75°C conductors in switches rated 30 100 ampere, 75°C conductors in switches rated 200 1200 ampere, copper conductors.

C. All current carrying parts shall be plated to resist corrosion.

D. Switches shall have removable arc suppressors to facilitate easy access to line side lugs.

E. Switches shall have provisions for a field installable electrical interlock.

F. Switch operating mechanism shall be quick make, quick break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started.

G. The operating handle shall be an integral part of the box, not the cover.

H. The handle position shall travel at least 90 degrees between OFF and ON positions to clearly distinguish and indicate handle position.

I. All switches shall have a dual cover interlock mechanism to prevent unintentional opening of the switch cover when the switch is ON and prevent turning the switch ON when the cover is open. The cover interlock mechanism shall have an externally operated override but the override shall not permanently disable the interlock mechanism. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

J. Switch enclosure shall be NEMA 1 unless otherwise on the Drawings or required by the NEC in accordance with the project conditions.

K. The enclosure shall be finished with Gray baked enamel paint which is electrodeposited on cleaned, phosphate pre treated steel (Type 1), or Gray baked enamel paint which is electrodeposited on cleaned, phosphate pre treated galvannealed steel (Type 3R).

L. The enclosure shall have ON and OFF markings on the cover to clearly identify the position of the switch.

M. All switches shall have provisions to lock the operating handle in the OFF position.

N. Tangential knockouts shall be provided to facilitate ease of conduit entry for switches rated 30 200A.

O. Enclosures for Type 3R switches through 200 ampere shall have provisions for interchangeable bolt on hubs in the top endwall.

P. Switches shall be horsepower rated for ac and/or dc as indicated on the plans.

Q. The UL listed short circuit current rating of the switches shall be: 200,000 rms symmetrical amperes when used with or protected by Class R fuses (30 600 ampere switches employing appropriate fuse rejection schemes).

2.3 SWITCH ACCESSORIES

A. Where switches are designated to be used as service entrance, the switch shall be labeled for such use.

B. Where fused switches are designated to have type "R" fuses, the switch shall be provided with rejection clips.

C. Provide fuse clip adaptors as required to accommodate smaller fuses when required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches to meet N.E.C. working clearance requirements.

B. Install fuses in fusible disconnect switches.

3.2 IDENTIFICATION

A. The requirements listed below are in addition to the requirements listed in Division 26 “Electrical Identification”.

B. Provide labeling on the exterior of each disconnect switch Stating the following:

1. What the piece of equipment is fed from the switch.
2. Where the piece of equipment is fed from the switch.
3. Size, type and quantity of fuses within cabinet.

3.3 FIELD QUALITY CONTROL

A. Subsequent to completion of installation of disconnects, energize circuits and demonstrate capability and compliance with requirements. Demonstrate switch operation through six (6) opening/closing cycles with circuit unloaded. Open each switch enclosure to display interior, mechanical and electrical connections and fuse installation, and for verification of type and rating of fuses installed. Where possible, correct deficiencies at project site, then retest or demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 26 28 16

SECTION 26 51 00 – LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.

1.2 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, provide typical cutsheets. Include data on features, accessories, and the following:

1. Light output in lumens, color temperature (CCT), color rendering index (CRI) and energy efficiency data.
2. Lighting fixture accessories.
3. Dimensions of fixtures.

B. Coordination: The electrical contractor shall be responsible to coordinate all light fixtures with ceiling installer before installation of ceiling grid. The electrical contractor shall also coordinate light fixture installation with HVAC and plumbing contractor for installation of piping and ductwork. Should there be any conflicts, they should be brought to the attention of the architect/engineer prior to the installation of the ceiling grid. Any conflicts not brought to the attention of the architect/engineer before installation of ceiling, the electrical contractor shall bare all costs associated with rework to install light fixtures, piping, ductwork, ceiling grid, etc.

1.3 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 70.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.4 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Provide from manufacturers as specified in the Lighting Fixture Schedules or on the drawings.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
2. Lens Thickness: 0.156 inch minimum, unless greater thickness is indicated.

2.3 LED DRIVERS

A. Provide low-energy LED drivers, capable of operating the LEDs indicated. Drivers shall operate at an input voltage between 120 to 277 VAC at an input frequency of 60 Hz +/- 10%. Light output shall remain constant for line voltage fluctuations within the range described. Drivers shall comply with EMI and RFI limits set by the FCC (CFR 41 Part 18) for non-residential applications and not interfere with normal electrical equipment. Drivers shall meet applicable ANSI standards and must be UL listed with the fixtures. Drivers shall provide 0-10V dimming operation, unless noted otherwise.

1. Where fixtures are connected to a switching device on the drawings, the 0-10V terminations shall remain unconnected.

B. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast.

2.4 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.
2. Internally Lighted Signs: As follows:

a. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

2.5 FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: ½-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

B. Twin-Stem Hangers: Two, ½-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

C. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

F. Independent Support Anchors: Anchors shall be on every fixture at the four (4) opposite corners. The contractor is required to independently support all recessed 1'x4', 2'x2', 2'x4', 4'x4', 2' diameter or larger fixture from all four corners. Circular fixtures smaller than 2' diameter, linear slot fixtures, etc. shall be support from at least two (2) opposite corners. Provide additional supports as recommended by the manufacturer.

G. Ceiling support steel for light fixtures: Support steel (unistrut) shall be installed to provide additional support for light fixtures from ceiling grid. Unistrut shall be installed above ceiling grid T-bars where the weight of the light fixtures require additional ceiling supports. Unistrut shall be supported independently from ceiling system.

2.6 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.

B. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

C. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Support for Fixtures in or on Grid-Type Suspended Ceilings. Fixtures shall be independently supported from building structure from all four corners of recessed fixtures including 2x4, 1x4, 2x2, 4x4, etc. and from opposite corners from recessed downlight and 1x1 fixtures to building steel. Wire shall be galvanized steel and rated for fixture, but not less than 14 gauge. Braided wire shall be acceptable.

C. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.

D. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

E. Suspended Fixture Support: As follows:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Chain Hung: Suspend with jack chain from structure.
4. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings.

F. Light fixtures shall be installed over junction boxes so they can be removed at a later date to access the wiring in the junction box.

G. Undercabinet Lighting: When installing undercabinet lighting, take care to hide all wiring. If there is a valance under the cabinet, wiring may exit the wall below the cabinet, and be run tight to the backside of the valance. If there is no valance, wiring shall exit the wall within the cabinet at a lower corner, run along the edge of the bottom shelf to the front of the cabinet to feed the end of the undercabinet light fixture. All exposed wiring shall be MC cable, and be tightly trained using straps and mechanical fasteners.

H. Where digital or analog dimming devices are indicated to control light fixtures, the required low and/or line voltage wiring shall be provided to control the fixture. Any and all additional accessories required shall be provided in their entirety.

3.2 CONNECTIONS

A. Ground equipment.

B. Furnish and install code compliant fixture disconnecting devices.

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.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests: As follows:

1. Verify normal operation of each fixture after installation.

a. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

C. Corrosive Fixtures: Replace during warranty period.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities. Inform Architect/Engineer when aiming fixtures.

END OF SECTION 26 51 00

SECTION 28 31 11 – FIRE ALARM AND DETECTION SYSTEM **(SIMPLEX)**

PART 1 - GENERAL

1.1 SUMMARY

A. This Section covers fire alarm systems, including, but not limited to initiating devices, notification appliances, controls, and supervisory devices. Any additional devices, wiring, etc. required for a complete and functioning system shall be provided as part of this specification.

B. The existing Simplex Fire Alarm System shall be expanded to add duct mounted smoke detectors to AHU-12. Provide all wiring, labor materials, equipment and parts to/for the system.

END OF SECTION 28 31 11