June 4, 2012

50% CONSTRUCTION DOCUMENTS

SPECIFICATIONS FOR
PIMA COUNTY COMMUNITY COLLEGE DISTRICT

Northwest Campus
New Building Expansion Project
7600 North Shannon Rd
TUCSON, AZ 85709

VOLUME 2

Facilities Planning Project # 09- 013

Pima County Community College District
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NORTHWEST CAMPUS EXPANSION
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PART 1 GENERAL

1.1 RELATED WORK

A. General Conditions

B. Special Conditions

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D. Architectural, Structural, Civil, Electrical and Mechanical Drawings & Specifications

1.2 SCOPE OF WORK

A. The work covered by the Fire Suppression Sections of the Specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of all mechanical and plumbing work required in the Contract Drawings.

B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified in this Section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.

C. The Contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field. The Contractor shall advise the Architect of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions, and the inclusion of all considerations for existing conditions.

1.3 PLANS AND SPECIFICATIONS

A. These Specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
B. If departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefor shall be submitted to the Architect for review. No departures shall be made without prior written acceptance of the Architect.

C. The interrelation of the specifications, the drawings, and the schedules is generally as follows: The specifications determine the nature and setting of the materials, the drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.

D. Should the drawings disagree in themselves or with the specifications, the contractor shall immediately notify the architect and shall perform and/or furnish the better quality or greater quantity of work or materials unless otherwise directed by the architect in writing. In case the specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on drawings govern scale measurements and large scale details govern small scale drawings. In case of disagreement between specifications and drawings, see Division I of these specifications for clarifications.

E. Items specifically mentioned in the specifications but not shown on the drawings and/or items shown on the drawings but not specifically mentioned in the specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

1.4 QUALITY ASSURANCE

A. All work shall comply with the applicable rules of the following:

1. 2006 International Building Code
2. 2006 International Mechanical Code
3. 2006 International Plumbing Code
4. 2006 International Fire Code
5. 2006 International Energy Conservation Code
6. National Fire Protection Association Codes
7. State Fire Marshall
9. All applicable city, county, state, and federal rules, codes, and ordinances.

B. In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. None of the terms or provisions of this specification shall be construed as waiving any rules, regulations, or requirements of these authorities. The codes shall govern in case of direct conflict between the codes and the Drawings.

1.5 SUPERVISION

A. A competent foreman or superintendent, initially approved by the Architect, shall be assigned to the project to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect. Architect's authorized representative and/or owner's observer shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's representative. Recommendations made by the observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect.

1.6 GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of two (2) years after the final acceptance of work.

1.7 UTILITIES

A. The contract documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such utility company charges and/or fees.

1.8 BUILDING CONSTRUCTION AND LAYOUT OF WORK

A. It shall be the responsibility of the Contractor to consult the architectural and engineering drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.
B. The Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and duct in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.

C. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect, and he reserves the right to make any reasonable changes in the locations indicated without additional cost.

1.9 SHOP DRAWINGS AND BROCHURES

A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of work. At least two weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data.

B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.

C. Each Shop Drawing shall indicate in the lower right hand corner and each Brochure shall indicate on the front cover the following: the Title of the Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract.
Drawings and/or Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:

I. Shop Drawings: Drawings shall be drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by skilled technicians experienced in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.

II. Brochures: Brochures shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space. Brochures not compiled in the manner described below shall be returned for resubmittal.

III. Brochures submitted shall contain only information which is relevant to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.

D. The submittal format shall follow the Specifications format with a submittal required for each section of Division 15. Each major category of equipment such as fans or pumps or air devices being submitted under a separate cover letter. The first submittal shall be accompanied by a three-ring hard back binder for the A/E to use in retaining copies of the submittals. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the A/E’s filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed manila index sheets also for the A/E’s filing convenience.

E. Submit six (6) copies of all Shop Drawings and Brochures for review and approval. One set will be retained by the Engineer, one set by the Architect for record purposes.

F. Minimum size of submittal data shall be 8-1/2" x 11".

G. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect reserved the right to require the Contractor to furnish items exactly as described in the Contract Documents.

H. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they are not equal. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will
furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Architect based on the particular circumstances.

1.10 SUBSTITUTIONS

A. The listing of product manufacturers, catalog numbers, etc., in the various sections of the specifications is intended to establish a standard of quality only, and is not intended to preclude open, competitive bidding. The Contractor may at his option submit substitute materials or methods which he feels are equal or superior to those specified. If the Contractor does submit alternate materials or methods, it shall be understood that the Contractor:

1. Has personally investigated the proposed substitute product and determined that it has all the same accessories and is equal or superior in all respects to the item specified.

2. Will provide the same guarantee for the substitution that he would for that specified.

3. Has coordinated the installation of the equipment which he proposes to substitute with all other trades especially in regard to electrical requirements and to operating weights trades and includes the costs for any changes required for the work to be complete in all respects. The Contractor will prepare shop drawings where required by the Architect or where dimensions vary.

4. Waives any and all claims for additional costs related to the substitution.

1.11 SPARE PARTS DATA

A. As soon as practicable after approval of materials and equipment, and, if possible, not later that one months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the contract. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee specified.
1.12 RECORD DRAWINGS

A. The Contractor shall keep a set of Drawings of the job, noting daily all changes made in the Drawings in connection with the final installation including exact dimensioned locations of all new and uncovered existing active and inactive utilities outside the building and shall turn over a clean, neatly marked set of sepia reproducible Drawings showing "as-built" work to the A/E for delivery to the Owner. All underground utilities and services and systems shall be accurately located by the Contractor and dimensioned on the "as-built" Drawings.

1.13 OPERATING AND MAINTENANCE MANUAL

A. Prepare and submit to the Architect for delivery to the Owner an indexed manual with complete technical data for every piece of equipment and material installed under this contract.

1. Complete fire suppression submittals as approved by Architect.

2. Manufacturer's installation instruction brochures.

3. Manufacturer's local representative and/or Distributor's name, address and phone number.

4. Manufacturer's operating and maintenance brochures.

B. This manual shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Sub-Contractors installing equipment represented in the brochure.

C. Contents of the Manual shall be grouped in sections according to the various sections of Division 21 and shall be listed in a Table of Contents.

PART 2 PRODUCTS

2.1 STANDARDS FOR MATERIALS

A. All materials, in general, shall conform to the requirements of all agencies of publications hereinbefore specified under the paragraph QUALITY ASSURANCE and shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this
listing, the Contractor may submit a statement from a nationally recognized testing agency indicating that the items have been tested in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

2.2 STANDARD PRODUCTS

A. Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

2.3 MANUFACTURERS INSTRUCTIONS

A. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor. If needed for proper installation, operation, or startup, the Contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Architect, he shall bear all costs arising in connection with the deficiencies.

2.4 RUST PREVENTION

A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

2.5 STORAGE ON SITE

A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is a suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

2.6 CAPACITIES

COMMON WORK RESULTS FOR FIRE SUPPRESSION 210500-8
A. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

2.7 NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

2.8 CONDITION OF MATERIAL AND APPURTENANCES

A. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of substantial completion, shall be replaced by the Contractor without extra cost to Owner.

PART 3 EXECUTION

3.1 INSTALLATION OF SYSTEMS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of system. No union will be required in welded lines or lines assembled with solder joint fittings, except at equipment items, machinery items, and other special pieces or apparatus. Companion flanges on lines at various items of equipment, machines and pieces of apparatus, shall serve as unions to permit removal of the particular items. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.

3.2 SPACE AND EQUIPMENT ARRANGEMENT

A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of other equipment.

B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly protected against damage.
3.3 PRECEDENCE OF WORK

A. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades.

3.4 EXCAVATION AND BACKFILL

A. The Contractor shall perform all excavation of every description required in the execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the drawings, or as required. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and causing cave-ins. Excavated materials not suitable for backfill shall be removed or stored as directed. Such grading shall be done as is necessary to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheeting and shoring shall be provided as required for the protection of the work and the safety of personnel.

B. Trenches shall be of the necessary width and depth to provide for proper laying of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on firm and undisturbed soil. Bell holes, of a size to permit proper grading, shall be provided as required. Over-depth excavations shall be backfilled to proper level with sand. When rock or other soil not suitable for bedding the pipe is encountered, it shall be removed to a depth of not less than 1' below grade, and backfilled with sand to grade, to provide a suitable bed for pipe. Existing underground piping shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired to the Architect's satisfaction, at the Contractor's expense.

C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with a minimum 6" sand cover over piping then backfilled with material (free from large earth clods, rocks, and/or foreign materials), laid in 6" layers, compacted to 90 percent of maximum dry density as determined by ASTM D698 (compaction shall be to 95 percent below structures, including sidewalks and roadways).

D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for as
distance of not less than 10' from the above features, as soon as possible. All damage resulting from flooding due to open trenches shall be paid for by the Contractor.

E. Where excavation requires, existing walks, street, drives, or other existing pavement shall be cut to install new lines and to make new connections to existing lines. The size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces, and shall be level with them.

3.5 CUTTING AND PATCHING

A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the observation of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written direction of the Architect.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by the cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.6 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. The Contractor shall provide his own hoisting facilities to set his materials and equipment in place in the building, as indicated on drawings and for subsequent cleaning, testing, and adjusting.

B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.7 CLEANING
A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.

B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

3.8 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Drawings or specified in the Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items' proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in the Electrical Specifications. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in the Electrical Specifications and shown on the Electrical Drawings.

END OF SECTION
SECTION 210523 - VALVES

PART 1 GENERAL

1.1 WORK INCLUDED

A. Gate Valves
B. Ball Valves
C. Check Valves
D. Butterfly Valves

1.2 RELATED WORK

A. Section 210500 – Common Work Results for Fire Suppression
B. Section 211313 - Wet Pipe Sprinkler Systems

1.3 SHOP DRAWINGS

A. Submit product data in accordance with Section 210500.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Valves as manufactured by KITZ, Nibco, Crane, Apollo, Watts or approved equal are acceptable provided they meet or exceed these specifications.
B. Provide valve types of same manufacturer throughout where possible.
C. Provide valves with manufacturer’s name and pressure rating clearly marked on outside of body.
D. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer’s option. Valves shall be of same make for all these services.
2.2 VALVE CONNECTIONS

A. Provide valves suitable for connection to adjoining piping as specified for pipe joints. Use pipe size valves unless otherwise indicated.

B. Provide threaded valves for pipe sizes 2 inches and smaller.

C. Provide flanged valves for pipe sizes 2 1/2 inches and larger.

D. Solder or screw to solder adaptors for copper tubing.

E. Use valve body suitable for mechanical coupling jointed piping.

F. Provide butterfly valves with full tapped lug bodies.

2.3 GATE VALVES

A. Select valves, equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves must be machined for accurate fit.

B. Comply with the following standards:

Bronze Valves: MSS SP - 80

C. Fire Sprinkler Service

1. Threaded ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge: Kitz #44, Nibco T-111, Crane 428 or equal. (Non-rising gate valves may be used where headroom prevents full extension of rising stems: Kitz #40, Nibco T-113, Crane 438 or equal)

2. Solder ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge: Kitz #44, Nibco S-111, Crane 428 or equal. (Non-rising stem gate valves may be used where headroom prevents full extension of rising stems: Kitz #41, Nibco S-113, Crane 438 or equal)

3. Flanged ends 2" and larger: Class 125 iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Kitz #72, Nibco F617-0, Crane 465-1/2 or equal.
2.4 BALL VALVES

A. Select with full port opening, blow out proof stem, hard chrome plated forged brass vented ball, adjustable packaging nut, rated not less than 600# W.O.G., 150 W.S.P.

B. Comply with the following standards:

Ball Valves: MSS SP - 110

C. Fire Sprinkler Service

1. Threaded ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #68, Nibco T-585-70, Apollo 77-100 Series, Watts 6080 or equal.

2. Solder ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #69, Nibco T-585-70, Apollo 77-200 Series, Watts B-6081 or equal.

2.5 BUTTERFLY VALVES

A. Where butterfly valves are used as shut-off for termination, or equipment removal or repair, select ductile iron lug type valves, bi-directional, dead-end service rated to the full working pressure of the valve. Provide gear operators on butterfly valves 8" and larger. Valve bodies to have extended necks to provide for 2-1/2" insulation as needed. Butterfly valves 12 inch and smaller rated to 200 psi, 14 inch and larger to 150 psi.

B. Comply with the following standards:

Butterfly Valves: MSS SP - 67

C. Fire Sprinkler Service

1. Lug type 2" and larger: Ductile iron body, lever operated, 10-position throttling handle 2-6 inch, 8 inch and larger gear operated, bronze disc, type 400 Series stainless steel stem, EPDM seat. Butterfly valves 12 inch and smaller rated to 200 psi, 14 inch and larger 150 psi.
D. Manufacturer subject to compliance with requirements, provide butterfly valves with one of the following: Kitz #6122E (Lug type), Milwaukee, ML233E (Lug), Nibco LD2000 (Lug) or equal.

2.6 CHECK VALVES

A. Comply with the following standards for design, workmanship, material and testing:

   Bronze Valves: MSS SP - 80

B. Construct valves of pressure casting free of any impregnating materials

C. Fire Sprinkler Service

   1. Threaded ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, bronze disc: Kitz #22, Nibco T-413B, Crane 37 or equal.

   2. Soldered ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, bronze disc: Kitz #23, Nibco T-413B, Crane 1342 or equal.

   3. Flanged ends 2-1/2" and larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Kitz #78, Nibco F918-B, Crane 373 or equal.

2.7 VALVE FEATURES

A. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.


C. Threaded valve ends comply with ANSI B2.1.

D. Solder Joint valve ends complying with ANSI B16.18.

E. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials; of standard alloy recognized in valve manufacturing that resist de-zincification.

F. Butterfly valve designed for flow regulation and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220 psi. No leakage permitted under test.

2.8 VALVE OPERATORS
A. Provide suitable handwheels for all valves.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Use U.L. approved valves in fire protection systems.

END OF SECTION
SECTION 210529 - SUPPORTS, ANCHORS AND SLEEVES FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 WORK INCLUDED
   A. Pipe Hangers and Supports

1.2 RELATED WORK
   A. Section 210500 – Common Work Results For Fire Suppression
   B. Section 211313 - Wet Pipe Sprinkler System

1.3 SUBMITTALS
   A. Submit shop drawings in accordance with Section 210500 Common Work Results For Fire Suppression.

1.4 REFERENCES

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Products shall be as manufactured by Grinnell, Elenz, Fee and Mason, Unistrut or approved equal.

2.2 INSERTS
   A. Malleable iron case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
   B. Size inserts to suit threaded hanger rods.

2.3 PIPE HANGERS AND SUPPORTS
   A. Hangers: Pipe sizes 1/2 inch to 1-1/2 inch: adjustable wrought steel ring.
B. Hangers: Pipe sizes 2 inches to 4 inches: adjustable wrought steel clevis.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

D. Vertical Support: Steel riser clamp.

E. Steel Beam Clamps: Elcen Figure 33, Type 3 or approved equal.

F. Expansion Anchors: Phillips Red Head or approved equal.

G. Design hangers to impede disengagement by movement of supported pipe.

2.4 HANGER RODS

A. Provide cadmium plated steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.5 SLEEVES

A. Pipes through Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with galvanized steel pipe.

B. Size large enough to allow for movement due to expansion and to provide for continuous installation.

PART 3 EXECUTION

3.1 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch or ducts over 60 inches wide.

C. Where concrete slabs form finished ceiling finish inserts, flush with slab surface.

3.2 PIPE HANGERS AND SUPPORTS

A. All structures and appurtenances employed for the purpose of supporting the pipe and guiding it properly shall be carefully fabricated in such a manner as to preserve the true grade of the pipe without subjecting either the pipe or the supporting and guidance members to any undue strain.
B. Support horizontal piping as follows:

C. Space hangers and furnish rods as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>Span (ft.) Steel</th>
<th>Span (ft.) Copper</th>
<th>Hanger Rod Diameter (in.)</th>
</tr>
</thead>
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<tr>
<td>1/2</td>
<td>5</td>
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<tr>
<td>4</td>
<td>10</td>
<td>10</td>
<td>5/8</td>
</tr>
</tbody>
</table>

D. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.

E. Place a hanger within one foot of each horizontal elbow.

F. Use hangers which are vertically adjustable 1-1/2 inch maximum after piping is erected.

G. Support piping at each change or direction, at ends of branches, at base and top of riser pipes and drops, and wherever necessary to prevent sag, bending or vibration, in addition to above-listed hanger spacing.

H. Support vertical piping at every floor.

3.3 PRIMING

A. Prime coat non-galvanized steel hangers and supports.

3.4 SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.
C. Where piping passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

D. Install chrome plated escutcheons where piping passes through finished surfaces.

E. Provide pipe sleeves for all piping.

F. Size pipe sleeves to permit placing pipe.

G. Sleeves for pipes through floor slabs standard weight galvanized steel pipe with top of sleeve projecting 2 inches above finished floor. For waterproof sleeves.

H. Sleeves for pipe through walls standard weight galvanized steel pipe or 18-gauge galvanized sheet metal with ends flush with wall surface.

I. Seal pipes passing through walls or slabs. Use mastic or oakum seal in the annular space in non-fire-rated walls; use Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal in the annular space in fire-rated walls or other envelopes.

J. Seal exposed pipe passing through floor slabs with Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal and point with caulking compound. Strike off flush at top of sleeve.

K. Sleeves penetrating exterior walls below grade shall be standard weight, black steel pipe with 1/4" thick steel plate secured to the pipe with a continuous fillet weld. The plate shall be located in the middle of the wall and shall be 4" wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. The pipe passing through the sleeve shall be centered within the sleeve and the annulus opening sealed with "Link Seal" casing seals manufactured by Thunderline Corporation, Wayne, Michigan. Series 300 for pipe sizes 1/2" through 10" and series 400 or 500 for larger pipe sizes or equal.

L. All piping shall be installed with due regard to expansion and contraction. Type of hanger, methods of support, location of supports, etc., shall be governed in part by this consideration.

END OF SECTION
SECTION 211313 - WET PIPE SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. All work performed under this Section of the Specifications shall be in strict accordance with the provisions of the General Conditions and Requirements, and Section 210500 Common Work Results For Fire Suppression.

1.2 WORK INCLUDED

A. The design and installation of a complete wet pipe automatic sprinkler system including exterior and interior water piping, sprinkler heads, valves, hangers and supports, sleeves, Fire Department connections and accessories.

B. Verification of all design criteria stated within these documents (including but not limited to Hazard Occupancy Classification, Design Density and Availability of Water) prior to bidding. If a conflict is found between the stated design criteria and any governing agency, the contractor shall notify the Architect prior to bidding.

1.3 RELATED WORK

A. Section 210500 – Common Work Results For Fire Suppression

B. Section 210523 – Valves For Fire Suppression

C. Section 210529 – Supports, Anchors and Sleeves For Fire Suppression

1.4 REFERENCE STANDARDS

A. NFPA No. 13: Sprinkler Systems

B. NFPA No. 24: Fire Department Connections

C. Local Fire Code and State Fire Marshal Requirements

1.5 QUALITY ASSURANCE

A. Sprinkler equipment, design and installation shall meet the requirements, recommendations of local authority having jurisdiction and the Owner's Insurance Underwriters.
B. The design, equipment furnished and installation shall meet the requirements of NFPA No. 13, "Standard for the Installation of Sprinkler Systems."

C. Systems shall be tested in accordance with NFPA-13. Test shall be witnessed by Architect and approved in writing prior to activation.

D. The system shall be designed and installed by a firm regularly engaged in the design and installation of automatic fire protection systems, in accordance with the requirements of the National Fire Protection Association, or by an authorized Agent of such firm. Evidence to support the above requirements may be requested, and any proposed installer who cannot show suitable experience will be rejected.

E. Standard Products: Materials and equipment shall be standard products of the manufacturer's latest design, and suitable to perform the functions intended. The name of the manufacturer, and the serial numbers, shall appear on all major components and shall bear the UL or FM label or marking. Equipment added to an existing system shall function in the same manner as similar components of the existing system.

F. Conformance to Agency Standards: Submit evidence of conformance of the entire system to the requirements of NFPA 13 standards, and of the Arizona State Fire Marshal and the Authorities having Jurisdiction. Required changes to meet code, insurance or jurisdictional authority requirements are to be made by the sprinkler contractor at no additional cost to the Owner.

1.6 SUBMITTALS

A. Submit shop drawings in accordance with Section 210500.

B. Fire sprinkler system shop drawings shall be submitted to the Architect prior to any submittals to any AHJ. The Architect's comments shall be incorporated into revised plans as required, shall be revised and resubmitted to the Architect for verification of compliance with design intent, and after Architect approval shall be submitted to the AHJ. If the AHJ makes revisions, the plans shall again be submitted to the Architect for review prior to resubmittal to the AHJ. No installation shall proceed without plans approved by both the Architect and the AHJ.

C. The shop drawings shall include detailed plans of sprinkler systems, calculations, sections and plot plan indicating the locations of underground supply connections, control valves, fire department connections, and other equipment to be used. Submit manufacturer's data on materials and equipment.
1.7 SYSTEM DESCRIPTION

A. System to provide full coverage for the entire building.

B. Provide a complete hydraulically designed system to meet NFPA 13 standards and occupancy requirements and hazard classifications as indicated on the drawings. Contractor shall be responsible for pressure and flow verification with the jurisdiction having authority prior to final design and system installation.

C. The location of equipment and piping mains shall conform as closely as possible to that shown on the plans. Contractor is advised, however, that the information shown on the plans is intended to indicate the general intent and scope of the project for bidding purposes only. Contractor shall use the drawings for reference only during bidding, and shall be fully responsible for the actual final arrangement of piping, head locations, and spacing and other system details as required to conform to the requirements of authorities having jurisdiction. Required changes to meet code, insurance, or jurisdictional authority requirements are to be made by the Sprinkler Contractor at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products manufactured by Automatic Sprinkler, ITT Grinnell, Viking, Central or approved equal meeting these specifications are acceptable.

B. All materials and equipment used in the installation of the fire protection system shall be listed as approved by the underwriters Laboratories, Inc., list of inspected Fire Protection Equipment and Materials, and the Factory Mutual Testing Laboratories list of approved equipment. Fire protection devices and devices involving fire hazard shall be the latest design of the manufacturer.

2.2 SPRINKLER PIPING AND PIPE FITTINGS

A. Piping Systems:

1. Pipe: Piping, fitting, valves, and installation shall be as specified in NFPA 13.

2.3 SPRINKLER HEADS

A. Unless otherwise specified or indicated on the drawings, sprinkler heads shall be regular automatic closed-type except that sprinkler heads to be installed in the vicinity of heating equipment and lights, shall be of the temperature rating required for such locations by National Fire Protection Association Standard No. 13.
B. In finished or suspended ceiling areas, provide recessed type sprinklers with chrome plated finish and white escutcheon.

C. In the Mechanical rooms, or exposed areas, provide upright sprinklers in bronze finish.

D. For sidewall application, provide sidewall sprinklers with chrome plated finish and escutcheon.

2.4 VALVES

A. Provide valves in accordance with Section 210523.

B. The fire riser shall have a main indicating butterfly valve for shut off control in accordance with Section 210523.

2.5 ALARM DEVICES

A. Riser water flow indicator switch shall be U.L. listed. Potter Model VSR-A or approved equal. Flow switch shall have two sets of contacts.

B. Sprinkler system control valves, riser butterfly valve indicator, post valves and other valves required by NFPA-13 or the local authority shall be furnished with a tamper switch. Tamper switch shall have two sets of contacts.

C. Furnish and install a 6" electric alarm bell.

2.6 SIAMESE FIRE DEPARTMENT CONNECTION

A. Provide two-way standard siamese fire department connection with chrome plated finish, local Fire Department thread, dust caps and chains, 3/4 inch automatic drip (connected to drain) marked "Automatic Sprinkler - Fire Department Connection".

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate the work of this Section with other affected work. This installation shall not cause interference with that of other trades.

B. All openings for piping should be anticipated and indicated on the approved and accepted shop drawings. Any additional cutting of openings must have the written approval of the Architect/Engineer.
3.2 INSTALLATION

A. Locate the fire department connection with sufficient clearance from walls or obstructions to allow full swing of fire department wrench handle.

B. Place pipe runs to avoid obstruction and interference with other work. Run piping in concealed spaces above finished ceilings. In exposed areas, piping will be kept at a minimum distance from the ceiling.

C. Piping shall allow for drainage at the riser. Trapped areas, if unavoidable, shall be provided with drains as required by NFPA 13.

D. Extend discharge of inspectors test valve, alarm valve and drains to curb or other point to avoid discharge across walks or into occupied areas.

E. Provide signs as required by Code to identify all items.

F. The fire protection system shall be tied into the building fire alarm system.

G. Support sprinkler piping from building structure with hangers and supports in accordance with NFPA Standard No. 13. Space hangers per NFPA No. 13. Furnish and install intermediate steel supports as required. Attach hangers or rods to concrete roof and floor structures with devices compatible with the structural types as approved by architect. Weight of piping and valves must be supported in a manner which does not impose eccentric loads on structural elements.

H. Actual number, spacing and location of heads, size and routes of piping shall be provided in accordance with the applicable Specifications and acceptable Shop Drawings.

I. All layouts, head spacing, coverage, etc., as may be required by the referenced authorities and/or Architectural and Structural conditions, shall be made without increase in cost to the Owner or the Architect. Pay careful attention to NFPA beam rules in laying out heads. Ducts, conduit bundles and other building items fall under the beam rules.

J. Heads shall be located in a symmetrical pattern related to ceiling features such as beams, light fixtures, diffusers, etc., and where applicable, heads shall be located symmetrical with the grid ceiling. Heads shall be centered (both directions) in a 2 x 2 ceiling tile or arranged in a manner acceptable to the Architect prior to installation. Heads protruding below escutcheon are not acceptable. Heads shall be semi-recessed. Carefully coordinate with other trades to avoid conflict with ducts, conduit, lights and structural items.
K. The Contractor shall provide spare heads equal to one percent of the total number of heads installed under the Contract, but not less than 10.

L. The heads shall be packed in a suitable sprinkler cabinet and shall be representative of, and in proportion to, the number of each type and temperature rating of heads installed.

M. In addition to the spare heads, the Contractor shall provide not less than one special sprinkler head-wrench for each type of head. The cabinet shall be located where directed by the Architect, or on the wall near sprinkler valve.

N. Run piping above furred ceiling and in joists to avoid obstructions. Coordinate with other trades to insure there are no conflicts or interferences.

O. Protect sprinkler heads in exposed areas against mechanical injury with standard guards.

P. Locate outside alarms on the wall of the building above the Fire Department connection.

Q. Fire sprinkler subcontractor shall be responsible for defining the required electrical connection to the Fire Alarm Panel with the electrical subcontractor. Electrical subcontractor will perform electrical installation of conduit and wire. Fire sprinkler subcontractor shall be responsible for coordinating work with the electrical subcontractor.

R. The service line entering the building shall have all joints strapped flange to flange for kickout protection. The building structure shall not be used as a kick block and full clearance through the building wall or floor shall be maintained.

3.3 ACCEPTANCE AND TESTING

A. During the fabrication and assembly of all piping, prior to testing and before connection is made to any equipment, the piping shall be blown with dry, oil-free compressed air to clear the pipe of dirt, welding slag and other materials which may be harmful to sprinkler heads and other equipment.

B. Prior to connecting to the overhead sprinkler piping, the underground main shall be flushed in the presence of the Architect and a representative of the authorities having jurisdiction and meet with their approval.

C. After completion of the installation, the entire system shall be tested by the contractor for acceptance by the authorities having jurisdiction.
D. The contractor shall provide and complete all forms required for testing and acceptance of the system. Copies of these documents shall be provided to the authorities having jurisdiction, the owner and the Architect, in accordance with Section 210500 Common Work Results For Fire Suppression.

END OF SECTION
SECTION 220500 – COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 RELATED WORK

A. General Conditions

B. Special Conditions

C. Supplementary General Conditions

D. Architectural, Structural, Civil, Electrical and Mechanical Drawings & Specifications

1.2 SCOPE OF WORK

A. The work covered by the Plumbing Sections of the Specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of all mechanical and plumbing work required in the Contract Drawings.

B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified in this Section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.

C. The Contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field. The Contractor shall advise the Architect of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions, and the inclusion of all considerations for existing conditions.

1.3 PLANS AND SPECIFICATIONS

A. These Specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.

B. If departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Architect for
review. No departures shall be made without prior written acceptance of the Architect.

C. The interrelation of the specifications, the drawings, and the schedules is generally as follows: The specifications determine the nature and setting of the materials, the drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.

D. Should the drawings disagree in themselves or with the specifications, the contractor shall immediately notify the architect and shall perform and/or furnish the better quality or greater quantity of work or materials unless otherwise directed by the architect in writing. In case the specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on drawings govern scale measurements and large scale details govern small scale drawings. In case of disagreement between specifications and drawings, see Division 1 of these specifications for clarifications.

E. Items specifically mentioned in the specifications but not shown on the drawings and/or items shown on the drawings but not specifically mentioned in the specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

1.4 QUALITY ASSURANCE

A. All work shall comply with the applicable rules of the following:

1. 2006 International Building Code
2. 2006 International Mechanical Code
3. 2006 International Plumbing Code
4. 2006 International Fire Code
5. 2006 International Energy Conservation Code
6. National Fire Protection Association Codes
7. State Fire Marshall
9. All applicable city, county, state, and federal rules, codes, and ordinances.
B. In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. None of the terms or provisions of this specification shall be construed as waiving any rules, regulations, or requirements of these authorities. The codes shall govern in case of direct conflict between the codes and the Drawings.

1.5 SUPERVISION

A. A competent foreman or superintendent, initially approved by the Architect, shall be assigned to the project to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect. Architect's authorized representative and/or owner's observer shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's representative. Recommendations made by the observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect.

1.6 GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of two (2) years after the final acceptance of work.

1.7 UTILITIES

A. The contract documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such utility company charges and/or fees.

1.8 BUILDING CONSTRUCTION AND LAYOUT OF WORK

A. It shall be the responsibility of the Contractor to consult the architectural and engineering drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.

B. The Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and duct in its exact location. These details are subject to the
requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.

C. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect, and he reserves the right to make any reasonable changes in the locations indicated without additional cost.

1.9 SHOP DRAWINGS AND BROCHURES

A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of work. At least two weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data.

B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.

C. Each Shop Drawing shall indicate in the lower right hand corner and each Brochure shall indicate on the front cover the following: the Title of the Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract Drawings and/or Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:
1. Shop Drawings: Drawings shall be drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by skilled technicians experienced in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.

2. Brochures: Brochures shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space. Brochures not compiled in the manner described below shall be returned for resubmittal.

3. Brochures submitted shall contain only information which is relevant to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.

D. The submittal format shall follow the Specifications format with a submittal required for each section of Division 15. Each major category of equipment such as fans or pumps or air devices being submitted under a separate cover letter. The first submittal shall be accompanied by a three-ring hard back binder for the A/E to use in retaining copies of the submittals. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the A/E's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed manila index sheets also for the A/E's filing convenience.

E. Submit six (6) copies of all Shop Drawings and Brochures for review and approval. One set will be retained by the Engineer, one set by the Architect for record purposes.

F. Minimum size of submittal data shall be 8-1/2" x 11".

G. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect reserved the right to require the Contractor to furnish items exactly as described in the Contract Documents.

H. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they are not equal. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the
Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Architect based on the particular circumstances.

1.10 SUBSTITUTIONS

A. The listing of product manufacturers, catalog numbers, etc., in the various sections of the specifications is intended to establish a standard of quality only, and is not intended to preclude open, competitive bidding. The Contractor may at his option submit substitute materials or methods which he feels are equal or superior to those specified. If the Contractor does submit alternate materials or methods, it shall be understood that the Contractor:

1. Has personally investigated the proposed substitute product and determined that it has all the same accessories and is equal or superior in all respects to the item specified.

2. Will provide the same guarantee for the substitution that he would for that specified.

3. Has coordinated the installation of the equipment which he proposes to substitute with all other trades especially in regard to electrical requirements and to operating weights trades and includes the costs for any changes required for the work to be complete in all respects. The Contractor will prepare shop drawings where required by the Architect or where dimensions vary.

4. Waives any and all claims for additional costs related to the substitution.

1.11 SPARE PARTS DATA

A. As soon as practicable after approval of materials and equipment, and, if possible, not later than one months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the contract. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee specified.

1.12 RECORD DRAWINGS
A. The Contractor shall keep a set of Drawings of the job, noting daily all changes made in the Drawings in connection with the final installation including exact dimensioned locations of all new and uncovered existing active and inactive utilities outside the building and shall turn over a clean, neatly marked set of sepia reproducible Drawings showing "as-built" work to the A/E for delivery to the Owner. All underground utilities and services and systems shall be accurately located by the Contractor and dimensioned on the "as-built" Drawings.

1.13 OPERATING AND MAINTENANCE MANUAL

A. Prepare and submit to the Architect for delivery to the Owner an indexed manual with complete technical data for every piece of equipment and material installed under this contract.

1. Complete submittals as approved by Architect.

2. Manufacturer's installation instruction brochures.

3. Manufacturer's local representative and/or Distributor's name, address and phone number.

4. Manufacturer's operating and maintenance brochures.

5. Replacement part number listings and/or descriptions.


7. Valve tag list.

B. This manual shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Sub-Contractors installing equipment represented in the brochure.

C. Contents of the Manual shall be grouped in sections according to the various sections of the specifications and shall be listed in a Table of Contents.

PART 2 PRODUCTS

2.1 STANDARDS FOR MATERIALS

COMMON WORK RESULTS FOR PLUMBING 220500-7
A. All materials, in general, shall conform to the requirements of all agencies of publications hereinbefore specified under the paragraph QUALITY ASSURANCE and shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized testing agency indicating that the items have been tested in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

2.2 STANDARD PRODUCTS

A. Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

2.3 MANUFACTURERS INSTRUCTIONS

A. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor. If needed for proper installation, operation, or startup, the Contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect's instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Architect, he shall bear all costs arising in connection with the deficiencies.

2.4 RUST PREVENTION

A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

2.5 STORAGE ON SITE
A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is a suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

2.6 CAPACITIES

A. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

2.7 NAMEPLATES

A. Each major component of equipment shall have the manufacturer’s name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

2.8 CONDITION OF MATERIAL AND APPURTEENANCES

A. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer’s recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of substantial completion, shall be replaced by the Contractor without extra cost to Owner.

PART 3 EXECUTION

3.1 INSTALLATION OF SYSTEMS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of system. No union will be required in welded lines or lines assembled with solder joint fittings, except at equipment items, machinery items, and other special pieces or apparatus. Companion flanges on lines at various items of equipment, machines and pieces of apparatus, shall serve as unions to permit removal of the particular items. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.

3.2 SPACE AND EQUIPMENT ARRANGEMENT

A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of other equipment.
B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly protected against damage.

3.3 PRECEDENCE OF WORK

A. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades.

3.4 EXCAVATION AND BACKFILL

A. The Contractor shall perform all excavation of every description required in the execution of his work. Excavation shall be through whatever substance encountered, to the depths indicated on the drawings, or as required. Excavated material suitable for backfill shall be piled in an orderly manner a sufficient distance from the trench to prevent overloading sides and causing cave-ins. Excavated materials not suitable for backfill shall be removed or stored as directed. Such grading shall be done as is necessary to protect the excavation from surface water. Trenches shall be maintained in a dry condition by bailing, pumping, or other approved methods. Pipe shall not be laid in wet trenches. Sheeteting and shoring shall be provided as required for the protection of the work and the safety of personnel.

B. Trenches shall be of the necessary width and depth to provide for proper laying of pipe and appurtenances, with banks as nearly vertical as possible. Bottoms of trenches shall be excavated to the grade and depth indicated or required, and barrel of pipe shall be laid on firm and undisturbed soil. Bell holes, of a size to permit proper grading, shall be provided as required. Over-depth excavations shall be backfilled to proper level with sand. When rock or other soil not suitable for bedding the pipe is encountered, it shall be removed to a depth of not less than 1' below grade, and backfilled with sand to grade, to provide a suitable bed for pipe. Existing underground piping shall be protected from damage during excavation and backfilling, and if damaged, shall be repaired to the Architect's satisfaction, at the Contractor's expense.

C. Trenches shall not be backfilled until all required tests have been performed. This requirement does not preclude sectional testing and backfilling of the various systems. Trenches shall be carefully backfilled with a minimum 6" sand cover over piping then backfilled with material (free from large earth clods, rocks, and/or foreign
materials), laid in 6" layers, compacted to 90 percent of maximum dry density as determined by ASTM D698 (compaction shall be to 95 percent below structures, including sidewalks and roadways).

D. Open trenches abutting foundation or basement excavations, building walls, and grade beams, will not be permitted, but shall be backfilled and completed, for a distance of not less than 10' from the above features, as soon as possible. All damage resulting from flooding due to open trenches shall be paid for by the Contractor.

E. Where excavation requires, existing walks, street, drives, or other existing pavement shall be cut to install new lines and to make new connections to existing lines. The size of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new materials is completed and the excavation has been backfilled, the paving shall be patched, using materials to match those cut out. The patches shall be thoroughly bound with the original surfaces, and shall be level with them.

3.5 CUTTING AND PATCHING

A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the observation of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written direction of the Architect.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by the cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.6 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. The Contractor shall provide his own hoisting facilities to set his materials and equipment in place in the building, as indicated on drawings and for subsequent cleaning, testing, and adjusting.
B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.

3.7 CLEANING

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.

B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

3.8 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Drawings or specified in the Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items' proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in the Electrical Specifications. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in the Electrical Specifications and shown on the Electrical Drawings.

END OF SECTION
SECTION 220523 - VALVES

PART 1  GENERAL

1.1  WORK INCLUDED

   A.  Gate Valves
   B.  Ball Valves
   C.  Check Valves
   D.  Balancing Valves

1.2  RELATED WORK

   A.  Section 220500 – Common Work Results for Plumbing
   B.  Section 221100 - Plumbing Piping

1.3  SHOP DRAWINGS

   A.  Submit product data in accordance with Section 15010.

PART 2  PRODUCTS

2.1  ACCEPTABLE MANUFACTURERS

   A.  Valves as manufactured by KITZ, Nibco, Crane, Apollo, Watts or approved equal are acceptable provided they meet or exceed these specifications.
   B.  Provide valve types of same manufacturer throughout where possible.
   C.  Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
   D.  Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be of same make for all these services.
2.2 VALVE CONNECTIONS

A. Provide valves suitable for connection to adjoining piping as specified for pipe joints. Use pipe size valves unless otherwise indicated.

B. Provide threaded valves for pipe sizes 2 inches and smaller.

C. Provide flanged valves for pipe sizes 2 1/2 inches and larger.

D. Solder or screw to solder adaptors for copper tubing.

2.3 GATE VALVES

A. Select valves, equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves must be machined for accurate fit.

B. Comply with the following standards:

Bronze Valves: MSS SP - 80

C. Domestic Water and Natural Gas Service

1. Threaded ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge: Kitz #44, Nibco T-111, Crane 428 or equal. (Non-rising gate valves may be used where headroom prevents full extension of rising stems: Kitz #40, Nibco T-113, Crane 438 or equal)

2. Solder ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, solid wedge: Kitz #44, Nibco S-111, Crane 428 or equal. (Non-rising stem gate valves may be used where headroom prevents full extension of rising stems: Kitz #41, Nibco S-113, Crane 438 or equal)

3. Flanged ends 2" and larger: Class 125 iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Kitz #72, Nibco F617-0, Crane 465-1/2 or equal.

2.4 BALL VALVES

A. Select with full port opening, blow out proof stem, hard chrome plated forged brass vented ball, adjustable packaging nut, rated not less than 600# W.O.G., 150 W.S.P.
B. Comply with the following standards:

Ball Valves: MSS SP - 110

C. Domestic Water Service

1. Threaded ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #68, Nibco T-585-70, Apollo 77-100 Series, Watts 6080 or equal.

2. Soldered ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #69, Nibco T-585-70, Apollo 77-200 Series, Watts B-6081 or equal.

D. Natural Gas Service

1. Threaded ends 2" and smaller: 175# W.O.G., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem, U.L. listed for natural gas service: Kitz #60, Nibco GB, Watts GBV or equal.

2.5 SWING CHECK VALVES

A. Comply with the following standards for design, workmanship, material and testing:

Bronze Valves: MSS SP - 80

B. Construct valves of pressure casting free of any impregnating materials

C. Domestic Water Service

1. Threaded ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, bronze disc: Kitz #22, Nibco T-413B, Crane 37 or equal.

2. Soldered ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, bronze disc: Kitz #23, Nibco T-413B, Crane 1342 or equal.

3. Flanged ends 2-1/2" and larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Kitz #78, Nibco F918-B, Crane 373 or equal.
2.6 BALANCING VALVES

A. Manual Balance Valve: Furnish and install as shown on plans, a calibrated (bronze/cast iron with bronze disc) balance valve equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral check valve designed to minimize system fluid loss during the monitoring process. The balancing valve shall have an indexing pointer and calibrated nameplate to indicate the degree of closure of the precision machined orifice. Each balancing valve is to be constructed with internal O-ring seals to prevent leakage around the rotating element. The balancing valves shall be supplied with performed polyurethane insulation, suitable for use on heating and cooling systems.

B. Automatic Balance Valves: Furnish threaded or flanged valves with cartridge, bronze or steel housing to match pipe material and pressure and temperature taps. Flow shall be accurate to a +/- 5% within a pressure range of 4 - 55 psi for Areas A,B,C,D & M; 2 - 30 psi for Areas E,F,G & H and 1 - 20 psi for Areas J & K. For flows below 30 gpm, combo valves may be used. Griswold Controls, Auto Flow or Hays valves are acceptable.

2.7 VALVE FEATURES

A. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.


C. Threaded valve ends comply with ANSI B2.1.

D. Solder Joint valve ends complying with ANSI B16.18.

E. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials; of standard alloy recognized in valve manufacturing that resist dezincification.

F. Butterfly valve designed for flow regulation and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220 psi. No leakage permitted under test.

2.8 VALVE OPERATORS

A. Provide suitable handwheels for all valves.
PART 3  EXECUTION

3.1  INSTALLATION

A.  Install valves with stems upright or horizontal, not inverted.

B.  Install ball valves for shut-off and isolating service, to isolate equipment, part of systems, or vertical risers.

C.  Provide shut-off valves and check valves on discharge of pumps.

D.  Install check valves in horizontal position with pin horizontally perpendicular to center line of pipe.  Install for proper direction of flow. Installations on any vertical piping must be up flow only.

E.  Valves used for natural gas shall be listed for such use.

F.  All valves shall be located so that the bonnets can be removed.

G.  Where valves are installed concealed in pipe chases provide Zurn Z-1460-4 or approved equal access doors with concealed hinge and key operated locks. Door shall be large enough to service valves and shall be installed flush with finished walls.

H.  Provide brass tag for each valve labeling the fluid in the pipe, the area served, and the normal operating position.

END OF SECTION
SECTION 220529 - SUPPORTS, ANCHORS AND SLEEVES FOR PLUMBING

PART 1 GENERAL

1.1 WORK INCLUDED

A. Pipe Hangers and Supports

1.2 RELATED WORK

A. Section 220500 – Common Work Results For Plumbing

B. Section 221100 - Plumbing Piping

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 220500 Common Work Results For Plumbing.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall be as manufactured by Grinnell, Elcen, Fee and Mason, Unistrut or approved equal.

2.2 INSERTS

A. Malleable iron case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

B. Size inserts to suit threaded hanger rods.

2.3 PIPE HANGERS AND SUPPORTS

A. Hangers: Pipe sizes 1/2 inch to 1-1/2 inch: adjustable wrought steel ring.

B. Hangers: Pipe sizes 2 inches to 4 inches: adjustable wrought steel clevis.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

D. Vertical Support: Steel riser clamp.
E. Steel Beam Clamps: Elcen Figure 33, Type 3 or approved equal.

F. Expansion Anchors: Phillips Red Head or approved equal.

G. Design hangers to impede disengagement by movement of supported pipe.

H. Provide copper plated hangers and supports for copper piping or two layers Scotch 33 PVC tape or equal.

2.4 HANGER RODS

A. Provide cadmium plated steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.5 SLEEVES

A. Pipes through Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with galvanized steel pipe.

B. Size large enough to allow for movement due to expansion and to provide for continuous installation.

PART 3 EXECUTION

3.1 PIPE HANGERS AND SUPPORTS

A. All structures and appurtenances employed for the purpose of supporting the pipe and guiding it properly shall be carefully fabricated in such a manner as to preserve the true grade of the pipe without subjecting either the pipe or the supporting and guidance members to any undue strain.

B. Support horizontal piping as follows:

C. Space hangers and furnish rods as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>Span (ft.)</th>
<th>Hanger Rod Diameter (in.)</th>
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<tbody>
<tr>
<td></td>
<td>Steel</td>
<td>Copper</td>
</tr>
<tr>
<td>1/2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3/4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>6</td>
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<tr>
<td>1-1/2</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>9</td>
</tr>
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<td>3</td>
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</tbody>
</table>

SUPPORTS, ANCHORS & SLEEVES FOR PLUMBING 220529-2
D. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.

E. Place a hanger within one foot of each horizontal elbow.

F. Use hangers which are vertically adjustable 1-1/2 inch maximum after piping is erected.

G. Support piping at each change or direction, at ends of branches, at base and top of riser pipes and drops, and wherever necessary to prevent sag, bending or vibration, in addition to above-listed hanger spacing.

H. Pipe hangers on insulated lines shall be sized to fit the outside of the insulation.

I. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers, designed to support loads per ANSI B31.1.

J. Where practical, support riser piping independently of connected horizontal piping.

3.2 EQUIPMENT BASES AND SUPPORTS

A. Provide for major equipment minimum four inch thick reinforced concrete house-keeping bases poured directly on structural floor slab pinned in place and extended 6 inches minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment. Coordinate with other trades.

B. Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

C. Provide rigid anchors to ducts and pipes immediately after vibration connections to equipment.

3.3 PRIMING

A. Prime coat non-galvanized steel hangers and supports.

3.4 SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

D. Install chrome plated escutcheons where piping passes through finished surfaces.

E. Size pipe sleeves to permit placing pipe and specified insulation material for pipes passing through concrete or masonry walls or concrete slabs.

F. Sleeves for pipes through floor slabs standard weight galvanized steel pipe with top of sleeve projecting 2 inches above finished floor. For waterproof sleeves.

G. Sleeves for pipe through walls standard weight galvanized steel pipe or 18-gauge galvanized sheet metal with ends flush with wall surface.

H. Seal pipes passing through walls or slabs. Use mastic or oakum seal in the annular space in non-fire-rated walls; use Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal in the annular space in fire-rated walls or other envelopes.

I. Seal exposed pipe passing through floor slabs with Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal and point with caulking compound. Strike off flush at top of sleeve.

J. Insulated pipe shall be insulated in sleeves, caulked and pointed as above.

K. Sleeves penetrating exterior walls below grade shall be standard weight, black steel pipe with 1/4" thick steel plate secured to the pipe with a continuous fillet weld. The plate shall be located in the middle of the wall and shall be 4" wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. The pipe passing through the sleeve shall be centered within the sleeve and the annulus opening sealed with "Link Seal" casing seals manufactured by Thunderline Corporation, Wayne, Michigan. Series 300 for pipe sizes 1/2" through 10" and series 400 or 500 for larger pipe sizes or equal.

L. Pipe sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided for roof penetrations.

M. All piping shall be installed with due regard to expansion and contraction. Type of hanger, methods of support, location of supports, etc., shall be governed in part by this consideration.

END OF SECTION
SECTION 220640 - PLUMBING FIXTURES

PART 1  GENERAL

1.1 WORK INCLUDED

A. Water Closets

B. Urinals

C. Lavatories

D. Sinks

E. Service Sinks

F. Electric Water Coolers

1.2 RELATED WORK

A. Section 220500 – Common Work Results For Plumbing

B. Section 220529 - Supports, Anchors and Sleeves For Plumbing

C. Section 221100 - Plumbing Piping

1.3 REFERENCES

A. ANSI A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

B. ANSI A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.


D. ANSI A112.19.2 - Vitreous China Plumbing Fixtures.

E. ANSI A112.19.4 - Porcelain Enamel Formed Steel Plumbing Fixtures.

F. ANSI A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

G. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
1.4 QUALITY ASSURANCE

A. Fixtures: By same manufacturer for each type of product specified throughout.

B. Trim: By same manufacturer for each type of product specified throughout.

C. Determine that intended fixtures fit the available space with adequate service clearance, prior to submittal.

1.5 SUBMITTALS

A. Submit product data in accordance with Section 220500.

B. Include fixtures, sizes, [rough-in dimensions], utility sizes, trim, and finishes.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data in accordance with Section 220500.

B. Include fixture trim exploded view and replacement parts lists.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - FIXTURES

A. Products manufactured by American Standard, Crane, Eljer, Elkay, Just, Kohler, or approved equal meeting these specifications are acceptable.

2.2 ACCEPTABLE MANUFACTURERS - Fixture Trim

A. Products manufactured by American Standard, Bradley, Chicago Faucet, CHG Brass, Eljer, Moen, Royal Brass, Symmons, Kohler, Water Saver, Sloan, T&S Brass or approved equal meeting these specifications are acceptable.

2.3 ACCEPTABLE MANUFACTURERS - P-TRAP, STOP & SUPPLIES INSULATION

A. Products manufactured by McGuire, Plumberex, Truebro or approved equal meeting these specifications are acceptable.

2.4 ACCEPTABLE MANUFACTURERS - FLUSH VALVES

A. Products manufactured by Sloan, Delany, or approved equal meeting these specifications are acceptable.
2.5 ACCEPTABLE MANUFACTURERS - WATER CLOSET SEATS

A. Products manufactured by Beneke, Church, Olsonite, or approved equal meeting these specifications are acceptable.

2.6 ACCEPTABLE MANUFACTURERS - FIXTURE CARRIERS

A. Products manufactured by Josam, J. R. Smith, Zum, Wade, Watts or approved equal meeting these specifications are acceptable.

2.7 ACCEPTABLE MANUFACTURERS - MIXING VALVES (THERMOSTATIC)

A. Products manufactured by Leonard, Powers or approved equal meeting these specifications are acceptable.

2.8 ACCEPTABLE MANUFACTURERS - ELECTRIC WATER COOLERS

A. Products manufactured by Elkay, Haws, Oasis, or approved equal meeting these specifications are acceptable.

PART 3 EXECUTION

3.1 INSPECTION

A. Review architectural drawings. Confirm location and size of fixtures and openings before rough-in and installation.

B. Verify adjacent construction is ready to receive rough-in work of this Section.

3.2 INSTALLATION

A. Install each fixture with trap, easily removable for servicing and cleaning.

B. Provide chrome plated rigid or flexible supplies to fixtures with loose key and/or screwdriver stops reducers, and escutcheons.

C. Install components level and plumb.

D. Install and secure fixtures in place with wall supports and/or wall carriers and bolts.

E. Mount fixtures at heights per code.
3.3 ADJUSTING AND CLEANING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion clean plumbing fixtures and equipment.

END OF SECTION
SECTION 220719 - PLUMBING PIPING INSULATION

PART 1  GENERAL

1.1  WORK INCLUDED

A. Insulation of Domestic Hot Water Piping

1.2  RELATED WORK

A. Section 220500 – Common Work Results For Plumbing

B. Section 221100 - Plumbing Piping

1.3  QUALITY ASSURANCE

A. All insulation materials required for piping, and mechanical equipment, etc. shall be furnished and installed under this contract. The execution of the work shall be by approved insulation contractor in strict accordance with the best practice of the trade and the intent of this Specification.

B. It is mandatory that all insulation be applied in a neat and workmanlike manner. Contractor shall be required to remove and replace all insulation not applied in strict accordance with manufacturer's specifications or not presenting a neat finished appearance.

C. All insulation on indoor work shall have composite (insulation, jacket or facing, and adhesive used to adhere jacket or facing to the insulation) fire and smoke hazard Ratings, as tested by procedure ASTM E-84, NFPA 255 and UL 73 not exceeding Flame Spread of 25, Fuel Contributed of 50 and Smoke Developed of 50. Accessories, such as adhesives, mastics, cements, tapes and cloths for fittings shall have component ratings as listed above.

D. Insulation shall be continuous through wall, floor and ceiling openings and sleeves.

E. Specified mastics, adhesives and coatings shall be applied in strict accordance with manufacturer's instructions, including recommended coverages.

1.4  SUBMITTALS

A. Submit materials and installation instructions in accordance with Section 22 0000 Plumbing.
PART 2  PRODUCTS

2.1  ACCEPTABLE MANUFACTURERS

A.  Products manufactured by Owens-Corning, Knauf, Johns Manville, Certain-Teed, Govain, Benjamin Foster are acceptable provided they meet or exceed these specifications.

2.2  PIPING

A.  Piping:

1.  Insulation thickness - Fiberglass pipe covering.

<table>
<thead>
<tr>
<th>PIPING TYPE</th>
<th>PIPE SIZE</th>
<th>INSULATION SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Hot Water Supply &amp; Return</td>
<td>2&quot; &amp; under</td>
<td>1&quot;</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; &amp; up</td>
<td>1-1/2&quot;</td>
</tr>
</tbody>
</table>

2.  All fiberglass pipe insulation shall be nominal 5 pcf density.

3.  Insulation jacket shall be factory applied white All Service Jacket (ASJ), with factory supplied self- sealing laps.

4.  Fittings, Valves and Flanges:

a.  Where manufactured, factory premolded fittings (of the same material and thickness as the pipe insulation) shall be used for all fittings, flanges and valves.

b.  Where premolded insulation fittings are not manufactured, all fittings, flanges and valves shall be insulated with mitered segments of nominal 5 lb. density fiberglass pipe covering.  Hot Service Finish: embed a 20 x 20 weave white glass reinforcing cloth between two 1/16 inch coats of Benjamin Foster 30-36.  The glass cloth and second coat shall overlap adjacent covering by at least two inches.  Cold Service Finish: same as above except use Benjamin Foster 30-35.

c.  Insulation for removable flanges of pipe strainers shall be fabricated with built-up sections of Fiberglass pipe covering, so arranged as to facilitate servicing of the strainer.  Applications for cold services shall be complete with vapor seals.
6. Insulation on pipes shall be protected by saddles from hangers, guides, and rollers.

7. Any piping subject to freezing shall be covered with minimum layer of 2 inch fiberglass. Install heating cable when specified between pipe and insulation.

PART 3 EXECUTION

3.1 PREPARATION

A. Do not install covering before piping and equipment has been tested and approved.

B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 INSTALLATION

A. Provide a minimum 12" long, high density insulation insert such as calcium silicate or its equivalent at each support. Insert shall be the same thickness as adjacent piping.

B. Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed.

C. Insulate fittings and valves. Do not insulate unions, flanges, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material troweled on bevel.

D. Finish insulation neatly at hangers, supports and other protrusions.

E. Locate insulation cover seams in least visible locations.

F. Cold Piping: Cover fittings and valves with equivalent thickness of insulation material. Cover with open mesh glass cloth sealed with vapor barrier sealant. Seal lap joints with 100% coverage of vapor barrier sealant and adhesive. Seal butt joints with 4 inches wide strips of vapor barrier sealed with vapor barrier adhesive. For exposed fittings and valves, apply hydraulic setting cement paste over insulation material before applying canvas jacket.

G. Hot Piping: Cover fittings and valves with equivalent thickness of insulation material. For exposed fittings and valves apply hydraulic setting cement paste over insulating material before applying canvas jacket.

H. Cover exposed insulation with 8 oz. canvas jacket.
1. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

END OF SECTION
SECTION 221100 - PLUMBING PIPING

PART 1  GENERAL

1.1 WORK INCLUDED

A. Sanitary Sewer Piping
B. Domestic Water Piping
C. Rainwater Piping
D. Natural Gas Piping

1.2 RELATED WORK

A. Section 220000 – Common Work Results For Plumbing
B. Section 220523 – Valves For Plumbing
C. Section 220529 - Supports, Anchors and Sleeves For Plumbing
D. Section 220640 - Plumbing Fixtures
E. Section 220719 - Plumbing Piping Insulation
F. Section 221119 - Plumbing Specialties

1.3 REFERENCES

A. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 NS 300.
B. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
C. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder. Joint Drainage Fittings - DWV.
D. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications.
E. ANSI/ASTM B32 - Solder Metal.

H. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

I. ASTM A74 - Cast Iron Soil Pipe and Fittings.

J. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses.

K. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

L. ASTM B88 - Seamless Copper Water Tube.

M. ASTM B306 - Copper Drainage Tube (DWV).


O. AWS 5.8 - Brazing Filler Metal.


1.4 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ANSI/ASME Sec. 9.

1.5 SUBMITTALS

A. Submit product data in accordance with Section 220500.

B. Include data on pipe materials, pipe fittings, and accessories.

PART 2 PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

2.2 SANITARY SEWER PIPING, ABOVE GRADE


2.3 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING


2.4 WATER PIPING, ABOVE GRADE


2.5 RAINWATER PIPING, BURIED WITHIN 5 FEET OF BUILDING


2.6 RAINWATER PIPING, ABOVE GRADE


2.7 NATURAL GAS PIPING, ABOVE GRADE


2.8 LABORATORY VACUUM PIPING

2.9 LABORATORY AIR PIPING

2.10 FLANGES, UNIONS, AND COUPLINGS
A. Pipe Size 2 Inches and Under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
B. Pipe Size Over 2 Inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; neoprene gaskets for gas service; 1/16 inch thick preformed neoprene bonded to asbestos.
C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

PART 3 EXECUTION
3.1 PREPARATION
A. Ream pipe and tube ends. Remove burrs.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION
A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
B. Route piping in orderly manner and maintain gradient.
C. Install piping to conserve building space and not interfere with use of space.
D. Group piping whenever practical at common elevations.
E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Provide clearance for installation of insulation and access to valves and fittings.

G. Provide access doors to match wall or ceiling construction where valves and fittings are not exposed.

H. Slope water piping and arrange to drain at low points.

I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

J. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting where exposed.

3.3 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

3.4 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
H. Take samples no sooner than 24 hours after flushing, from 2 percent of outlets and from water entry, and analyze in accordance with AWWA C601.

I. Submit statement of test results and procedures to Architect.

3.5 FLUSHING OF DOMESTIC WATER PIPING SYSTEM

A. Prior to start of work, verify system has been disinfected per paragraph 3.4 of this section.

B. All installed plumbing fixtures shall be rinsed (ran) daily for a minimum of 30 seconds each. This shall continue for a minimum period of one (1) week.

C. At the conclusion of the flushing cycle, verification samples may be collected by a school representative for testing.

D. Records of flushing must be maintained and available for inspection.

3.6 TESTING

A. Test soil and vent systems by plugging lines and filling systems with water to a static head of ten (10) feet of water. Observe water level for two (2) hours. If level is lowered, indicating leakage, repair leaks and test again until no further leakage is detected.

B. Test water piping at 100 psig for a continuous period of four (4) hours. During this time, carefully inspect the system for leaks. If necessary, repair leaks and test again until no further leakage is detected.

END OF SECTION
SECTION 221119 - PLUMBING SPECIALTIES

PART 1  GENERAL

1.1 WORK INCLUDED

A. Roof and Floor Drains
B. Cleanouts
C. Backflow Preventers
D. Water Hammer Arrestors
E. Thermostatic Mixing Valves
F. Hose Bibbs and Hydrants
G. Trap Primers

1.2 RELATED WORK

A. Section 220500 – Common Work Results For Plumbing
B. Section 220529 - Supports, Anchors and Sleeves For Plumbing
C. Section 220640 - Plumbing Fixtures
D. Section 221100 - Plumbing Piping

1.3 REFERENCES

A. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.
B. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
C. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
E. ANSI A112.21.1 - Floor Drains.
F. ANSI A112.21.2 - Roof Drains.


H. PDI WH-201 Water Hammer Arrestors.

1.4 QUALITY ASSURANCE

A. Manufacturer: For each type of product specified, provide components by same manufacturer throughout.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 220500.

B. Include component sizes, rough-in requirements, service sizes, and finishes.

PART 2 PRODUCTS

2.1 ROOF DRAINS

A. Manufacturers: Josam, J.R. Smith, Wade, Watts, Zurn or approved equal meeting these specifications are acceptable.

2.2 FLOOR DRAINS

A. Manufacturers: Josam, J.R. Smith, Watts, Zurn or approved equal meeting these specifications are acceptable.

2.3 FLOOR SINKS

A. Manufacturers: Josam, J.R. Smith, Watts, Zurn or approved equal meeting these specifications are acceptable.

2.4 DOWNSPOUT NOZZLE

A. Manufacturers: Josam, J.R. Smith, Watts, Zurn or approved equal meeting these specifications are acceptable.

2.5 CLEANOUTS

A. Manufacturers: Josam, J.R. Smith, Wade, Watts, Zurn or approved equal meeting these specifications are acceptable.

PLUMBING SPECIALTIES
B. Exterior Surfaced Areas: Round coated cast iron body with cast iron non-skid cover and plug; Model 4225 manufactured by J.R. Smith.

C. Exterior Unsurfaced Areas: Line type with coated cast iron body and round gasketed cover; Model 4255 manufactured by J.R. Smith.

D. Interior Finished Floor Areas: Coated cast iron body with round nickel bronze scoriated cover; Model 4020 manufactured by J.R. Smith.

E. Interior Finished Wall Areas: Line type with coated cast iron body and cast iron lead seal plug, and round stainless steel access cover secured with machine screw; Model 4402 manufactured by J.R. Smith.

F. Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.6 BACKFLOW PREVENTERS

A. Manufacturers: Braukmann, Febco, Hersey Beeco, Watts, or approved equal meeting these specifications are acceptable.

B. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013; Bronze body with bronze and plastic internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve which opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks; Model 825Y, manufactured by Febco.

2.7 WATER HAMMER ARRESTORS

A. Manufacturers: Josam, J.R. Smith, Wade, Watts, Zurn, or approved equal meeting these specifications are acceptable.

B. ANSI A112.26.1; Sized in accordance with PDI WH-201, precharged suitable for operation in temperature range - 100 to 300 degrees F and maximum 250 psig working pressure; Model 5000 Series manufactured by J.R. Smith. Sized on drawings using P.D.I. symbols.

2.8 THERMOSTATIC MIXING VALVES

A. Manufacturers: Leonard, Powers, or approved equal meeting these specifications are acceptable.
2.9 HOSE BIBBS AND HYDRANTS

A. Manufacturers: Chicago, Josam, J.R. Smith, Watts, Wade, Woodford or approved equal meeting these specifications are acceptable.

2.10 TRAP PRIMERS

A. Manufacturers: Josam, J.R. Smith, PPP, Watts, or approved equal meeting these specifications are acceptable.

PART 3 EXECUTION

3.1 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer’s instructions to permit intended performance.

B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in 18 x 18 x 6 inch concrete pad flush with grade.

D. Encase exterior floor sinks in 18 x 18 x 6 inch concrete pad, 6 inches above grade.

E. Install water hammer arrestors complete with access door and isolation valve.

F. Install trap primer complete with access door and isolation valve.

G. Provide backflow preventer at connection of domestic potable water system to any component which might lead to contamination of the water system.

END OF SECTION
SECTION 222000 – LABORATORY PLUMBING

PART 1 - GENERAL

1.1 INTENT OF LABORATORY PLUMBING SPECIFICATION SECTION

A. The intent of this section is to provide information which is supplemental to all other divisions and sections of the specifications, and in particular to Division 22 Plumbing work, which shall be specifically related to the plumbing construction within the areas defined under the Laboratory scope of work. It is not intended to make any deletions, either explicitly or implicitly, to any of the other division or section requirements, and these sections do not relieve the Contractor from complying in all respects with other divisions and sections of the specifications. The other divisions and sections shall be considered to be an integral part of the Laboratory Plumbing work and shall be modified only as defined herein. Any questions the Contractor has with respect to the intent of the Laboratory Plumbing work sections should be addressed during the bidding period. Clarifications will be provided upon written request.

1.2 WORK INCLUDED

A. Provide complete plumbing systems from point of rough-in and final connections as described in these specifications and as shown on the Contract Drawings. Plumbing installations shall include all piping, valves, connectors and miscellaneous equipment to provide complete operable systems, in accordance with the best practices of the trade.

B. Except as modified by this section, all products, equipment, installation procedures, and general conditions contained within Division 22 Plumbing sections of these specifications applies to work specified in this section.

C. Work under this section includes, but is not limited to, installation of branch supply piping from main piping systems to points of termination within the laboratories, as well as laboratory waste and vent piping from between floor and ceiling.

D. Work NOT included under this section is as follows:
   1. Laboratory waste piping below point of connection at the floor slab
   2. Laboratory vent piping beyond point of connection above ceiling
   3. Building distribution main piping systems
   4. Fire sprinkler systems
   5. Steam and condensate piping systems

LABORATORY PLUMBING
1.3 RELATED WORK DESCRIBED ELSEWHERE

A. General and Supplementary Conditions and Division 1
B. Section 115310 – Laboratory Casework and Other Furnishings
C. Section 115313 – Fume Hoods and Other Air Containment Units
D. Section 115343 – Laboratory Service Fittings and Fixtures
E. Section 115353 – Laboratory Equipment
F. Division 22 – Plumbing
G. Division 23 – Heating Ventilating and Air Conditioning
H. Division 26 – Electrical

1.4 REFERENCES

A. In addition to complying with all applicable trade and building codes and regulations, comply with applicable portions of the National Sanitation Foundation (NSF) standards.

1.5 DEFINITIONS

A. Above Finished Floor: Inside building within a zone usually considered at ± 6" above floor finish.
B. Above Finished Ceiling: Inside building within a zone usually considered at ± 6" above ceiling finish.
C. Below Slab: Located in ceiling space of floor below, buried in ground, or embedded in concrete slab on ground.
D. Concealed: Inside building, above grade and located within walls, furred spaces, service cores, pipe drop enclosures, above suspended ceilings, etc. In general any item not visible or directly accessible.
E. Connect: Complete hookup of item with required services, including all adapters and fittings.
F. Exposed: Either visible or subject to mechanical or weather damage, indoors or outdoors, including areas such as mechanical and storage rooms. In general any item that is directly accessible without removing panels, walls, ceiling or other parts of structure commonly used as reference to surface mounted piping, etc.
G.  Point of Connection: Point within a piped system at which responsibility of this section either begins or ends. i.e. laboratory waste begins at fixture outlet and ends at Point of Connection (P.O.C.) ± 6" above floor finish. From there to be continued on Plumbing Drawings, and remainder of Division 22 specifications.

1.6 CLOSING IN UNINSPECTED WORK

A.  Do not cover or enclose work prior to testing, inspection, and approval. All work covered or enclosed prior to approval and acceptance shall be re-opened. All finishes shall be restored.

1.7 SUBMITTALS

A.  Submit as specified herein and under provisions of Division 1 “Submittal Requirements”.

B.  Submittal shall be complete with all product data specified herein and organized by specification section in one binder. All submitted product data shall be referenced to the applicable paragraph number contained within this specification section.

C.  Manufacturer’s Data: Submit complete materials list, including catalog data, of all materials, equipment, and products for work in this section.

D.  Shop Drawings: Submit coordinated shop drawings depicting the work specified herein for actual fabrication and installation. Work shall be coordinated with other trades and building structural and architectural elements. Shop drawings shall include plans, elevations, and sections as required depicting the intended installation and final product. Drawings shall be electronically prepared in AutoCAD or similar software and submitted in a complete package with minimum ¼ inch = 1 ft scale format and maximum sheet size of Architectural “E” (30” x 42”).

1.8 RECORD DRAWINGS

A.  The Contractor shall maintain an up-to-date set of “red-line” prints, marked to indicate progress of the Project and all as-built conditions. Prints shall be updated on a daily basis, and shall be available for review at all times on the job site.

B.  Record Drawings shall indicate locations of all equipment and pipe rerouting, as well as any changes in locations or positions of equipment.

C.  Comply with Division 1 “Project Closeout” for Record Drawings requirements.
1.9 SUBSTITUTIONS

A. Approved Substitution/Approved Equal: In addition to the items required in Division 1, all substitution requests shall include item-by-item comparison of the proposed substitution to this project specification. A copy of the project specification shall be submitted, with each item and subsection of the project specification marked as “Comply” or “Not Comply.” In any cases where “Not Comply” is indicated, an explanation of the relative advantages of the proposed design shall be provided.

B. Substitution shall not affect dimensions shown on Drawings.

C. The Contractor shall pay for changes to the building design, including engineering design, detailing, utility and service requirements, and construction costs caused by the requested substitution.

D. Substitutions shall have no adverse effect on other trades, the construction schedule, or specified warranty requirements.

E. Maintenance and service parts shall be locally available for the proposed substitution.

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

A. Domestic and Industrial Cold, Hot, and Tepid Water:

1. Provide hard copper tube, ASTM B 88, Type L, seamless, water tube, drawn temper. Fittings shall be ASME B16.22, wrought copper, solder joint. All joints shall be soldered with ASTM B 32 lead-free alloys and water-flushable flux according to ASTM B 813.

2. Provide pipe and fittings as specified in Section 22 XX XX.

3. Flexible Connectors: Provide 150 psi WOG working pressure rating, single braid, and stainless steel hose with threaded end connections. Manufacturers: US Hose Corp., Hyspan, or approved equal.

4. Flexible Tubing: Provide ASTM B 88 Type L, soft, annealed, seamless copper tubing.

5. Water Hammer Arrestors: Provide ASSE 1010, ANSI A112.26.1, or PDIIWH 201 certified copper tube with piston arrestor constructed of Type K or L hard drawn copper body, brass piston with lubricated dual o-ring seals, and threaded wrought copper or brass MIP connector. Manufacturers: PPP Inc., Sioux Chief, or approved equal.
B. Purified Water:

1. Provide ASTM D4101 Schedule 80 high purity homopolymer polypropylene (PP) pipe and fittings manufactured to iron pipe sizes to meet the dimensional tolerances of ASTM D2122, with socket electrofusion joints. Manufacturers: Georg Fischer +GF+, or approved equal.

2. Provide ASTM D4101 Schedule 80 high purity virgin unpigmented polypropylene (PP) pipe and fittings manufactured to iron pipe sizes to meet the dimensional tolerances of ASTM D2122, with socket electrofusion joints. Manufacturers: Georg Fischer +GF+, Orion, or approved equal.

3. Provide ASTM D3222 Schedule 80 high purity virgin unpigmented polyvinylidene fluoride (PVDF) pipe and fittings manufactured to iron pipe sizes to meet the dimensional tolerances of ASTM D2447, with socket electrofusion joints. Manufacturers: Georg Fischer +GF+, Orion, or approved equal.

4. Provide ASTM F441 Schedule 80 high purity Corzan CPVC pipe manufactured for deionized water use. Fittings shall be ASTM F439 Schedule 80 socket joint manufactured for deionized water use. Socket joints shall use ASTM F656 solvent cement compatible with deionized water use and as recommended by the manufacturer. Manufacturers: IPEX, Charlotte Pipe & Foundry Co, or approved equal.

5. Provide ASTM D1785 Type I, Grade I Schedule 80 PVC pipe and socket joint fittings manufactured to iron pipe sizes to meet the dimensional tolerances of ASTM D2447. Fittings shall be ASTM F439 Schedule 80 socket joint with ASTM F656 solvent cement as recommended by the manufacturer.

6. Provide pipe and fittings as specified in Section 22 XX XX.

7. Pipe shall be cleaned and capped at time of manufacture.

8. Provide continuous (linear piping) tray-type channel support ("V" or "U" shaped sheet metal or fiberglass) along entire horizontal ceiling distribution of piping system.


C. Vacuum:

1. Provide ASTM B 88, Type L, seamless, hard-drawn, tempered, copper tubing. Fittings shall be ASME B16.22, wrought copper, solder joint. All joints shall be soldered with ASTM B 32 lead-free alloys and water-flushable flux according to ASTM B 813. Use long turn elbows and Y-fittings.

2. Provide pipe and fittings as specified in Section 22 XX XX.
3. Threaded joints in distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1 and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.


D. Compressed Air:

1. Provide ASTM B 88 Type L, seamless, hard-drawn, tempered, copper tubing. Tubing shall be cleaned, capped and delivered certified for "Medical Gas", "Oxygen Service", or equivalent cleanliness standard from the manufacturer. Fittings shall be ASME B16.22 wrought copper, brazed joints. All joints shall be silver brazed in accordance with ASTM F1076-87 with silver alloy filler Stay Silv 15, Sil-Fos 15, or equal.

2. Provide pipe and fittings as specified in Section 22 XX XX.

3. Threaded joints in distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1 and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.


E. Laboratory (Natural) Gas:

1. Provide Schedule ASTM A 53, Type E or S, Grade B, Schedule 40 black steel pipe. Fittings shall be ASME B16.3 malleable iron, Class 150, standard pattern, with ASME B1.20.1 threaded ends. Unions shall be ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and ASME B1.20.1 threaded ends. Use joint compound and tape suitable for natural gas systems.

2. Provide pipe and fittings as specified in Section 22 XX XX.

3. Flexible Connectors: Provide corrugated stainless steel tubing (CSST) connectors in locations indicated on the Laboratory Plumbing drawings. CSST shall comply with ANSI/AGA Standard LC-1 and bear an IAPMO classified marking. CSST tubing one-piece constructed of high tensile
strength austenitic stainless steel with polymer or polyethylene coating. Nuts and fitting shall be constructed of zinc-plated steel or brass.

a. Manufacturers:

1. BrassCraft Manufacturing
2. Tru-Flex Metal Hose Corporation
3. Omega Flex Inc
4. Titeflex Corporation
5. Ward Manufacturing
6. Or approved equal

b. All products specified in this section shall be the provided by a single manufacturer.

c. Length:

1. Provide 18 inch long at all laboratory gas service valve cocks and P.O.C.s to fume hoods.
2. Provide 24 inch long connections at ADA adjustable hoods and work stations.

F. Laboratory Waste and Vent:

1. Provide Schedule 40 flame-retardant polypropylene (PP) single containment pipe with sanitary type fittings. Manufacturers: Georg Fisher +GF+ Fuseal, Orion, or approved equal.

a. Joints:

1. Polypropylene (PP), fusion weld, per manufacturer's instructions. Installed behind walls, partitions, inaccessible ceiling spaces etc., unless otherwise noted.
2. Polypropylene (PP), mechanical joint, per manufacturer's instructions. Installed in areas exposed to view, accessible ceiling spaces, fixture P-trap connections (both ends), and areas subject to ease of retrofit of the system.
3. Mechanical joints within sink cabinets and other areas exposed to view shall be threaded or grooved style piping joints. Compression bands shall not be used in these locations.

2. Provide ASTM C 1053-90 UL classified transparent borosilicate glass drain and vent pipe. Fittings shall be stainless steel compression type couplings with Buna-N-Rubber liner and TFE seal ring installed in accordance with manufacturer's instructions. Manufacturers: Schott Kimax or approved equal.
3. Provide AISI 316 L high-grade austenitic stainless steel drain and vent hub and spigot push-fit connection pipe with EPDM gasket. Pipe and fittings shall be chemically descaled for enhanced corrosion protection and to provide a uniform matte silver finish. Manufacturers: Blucher-Josam or approved equal.

   a. Couplings: Heavy-Duty, ASTM A 666 Type 304, stainless-steel shield, bands, and fasteners and EPDM sleeve with integral center pipe stop.

      1). NPS 1-1/2 to NPS 4: 3-inch wide shield with 4 bands.
      2). NPS 5 to NPS 10: 4-inch wide shield with 6 bands.

4. Provide pipe and fittings as specified in Section 22 XX XX.

5. Provide chrome-plated brass waste piping for tailpiece, P-trap, and trap arm at exposed-to-view locations for installations of emergency eyewash Laboratory fixtures and wall-hung hand wash sinks.

G. Specialty Gases:

   1. Application:

      a. Nitrogen (N₂)

   2. Provide ASTM B 88 Type L, seamless, hard-drawn, tempered, copper tubing. Tubing shall be cleaned, capped and delivered certified for "Medical Gas", "Oxygen Service", or equivalent cleanliness standard from the manufacturer. Fittings shall be ASME B16.22 wrought copper, brazed joints. All joints shall be silver brazed in accordance with ASTM F1076-87 with silver alloy filler Stay Silv 15, Sil-Fos 15, or equal.

   3. Threaded joints in distribution piping shall be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment. All threads shall be tapered pipe threads complying with ANSI B1.20.1 and be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. Where threaded nipples are required these shall be I.P.S. brass.

2.2 VALVES

   A. Domestic and Industrial Cold, Hot, and Tepid Water:

      1. Fixture Supply Stop Valves:

2. Shutoff Valves:

a. Provide three-piece, full-port, bronze ball valve with stainless-steel trim and soldered ends. MSS SP-110, 600 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, stainless steel stem and ball (vented), blowout-proof stem. Manufacturers: Nibco S-590, Apollo series 82, or approved equal.

b. Provide ball valves as specified in Section 22 XX XX.

3. Check Valves:

a. Provide Class 125, bronze swing check valve with nonmettalic disc, MSS SP-80, Type 4, minimum 200 psi CWP rating, horizontal flow, Y-pattern, bronze body, renewable PTFE or TFE discs, and threaded ends with adjacent unions. Manufacturers: Watts, Nibco, or approved equal.

b. Provide Y-pattern check valves as specified in Section 22 XX XX.

4. Vacuum Breakers: Provide vacuum breakers on potable water services as accepted by local building Authority and as specified in Section 22 XX XX. Manufacturers: Watts, Sloan, or approved equal.

5. Back Flow Preventers: Provide reduced-pressure-principle backflow preventers on potable water services supplying laboratory equipment, as accepted by local building Authority, and as specified in Section 22 XX XX. Manufacturers: Watts, Conbraco, or approved equal.

6. Pressure regulators: Provide adjustable water pressure regulators service fitting connection size and as specified in Section 22 XX XX. Manufacturers: Watts Series N, Fisher Type 75A, or approved equal.

7. Ice Maker Water Valve Box:

a. Provide all-metal recessed wall box fabricated of minimum 20-gauge steel with steel faceplate. Provide white epoxy powder coated finish. Approximate overall dimensions: 7-inch wide x 7-inch high x 3-inch deep.

b. Valve box equipped with quarter turn, angle pattern, brass, stop ball valve with ½-inch MIP x ¼-inch compressing connections with integral top mounted water hammer arrester.

c. Manufacturers: LSP Products Group model OB-509 or approved equal.
8. Industrial Hot/Cold Water Valve Box with Waste Fitting (Stainless Steel):
   a. Provide recessed wall box fabricated of minimum 18-gauge type 304 stainless steel with satin finish. Approximate overall dimensions: 10 ½-inch wide x 10 ½-inch high x 3 5/8-inch deep.
   b. Valve box to be equipped with hot water, cold water, and waste fittings as required for equipment services. Provide valve box with hot and cold water vacuum breaker.
   c. Manufacturers: Acorn Engineering Company model 8186 or approved equal.

B. Purified Water:

1. Control, Branch and Shut-off Valves:
   a. Provide homopolymer polypropylene ball valves compatible with piping and fittings. Manufacturers: Georg Fischer +GF+ or approved equal.
   b. Provide high purity unpigmented polypropylene ball valves compatible with piping and fittings. Manufacturers: Georg Fischer +GF+, Orion or approved equal.
   c. Provide high purity virgin unpigmented polyvinylidene fluoride (PVDF) ball valves compatible with piping and fittings. Manufacturers: Georg Fischer +GF+, Orion, or approved equal.
   d. Provide high purity CPVC ball valves compatible with piping and fittings. Manufacturers: Georg Fischer +GF+, Orion, IPEX, Charlotte Pipe & Foundry Co., or approved equal.
   e. Provide PVC ball valves compatible with piping and fittings.
   f. Provide ball valves as specified in Section 22 XX XX.

2. Shutoff Valve Box:
   a. Provide recessed wall valve box fabricated of minimum 16-gauge welded steel with door, trim, full length piano hinge, and rollerball catch. Approximate overall dimensions: 8-inch wide x 8-inch high x 4-inch deep.
   b. Finish: Electrostatically applied baked white enamel coat over rust-inhibiting phosphate treated steel.
   c. Manufacturers: Williams Brothers Model WB, Acudor Product Inc., or approved equal.

3. Water Valve Box:
   a. Provide recessed wall box fabricated of minimum 20-gauge steel with white epoxy powder coated finish. Minimum clear interior dimensions: 8-inch wide x 8-inch high x 3-inch deep.
b. Valve box provided with ¾-inch service fitting rough-in opening for ½-inch NPS supply.

c. Manufacturers: Guy Gray Manufacturing Co., LSP Products Group, or approved equal.

C. Vacuum:

1. Shutoff Valves:

   a. Provide two-piece, full port, bronze ball valve with bronze trim and soldered ends, MSS SP-110, 600 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, bronze stem, brass ball with hard chrome plate, and blowout-proof stem. Manufacturers: Nibco S-585, Apollo series 77, or approved equal.

   b. Provide as specified in Section 22 XX XX.

2. Check Valves: Size 2-inch and smaller: Provide Nibco S-433, Jenkins or equal, 150 psi SWP bronze check valve, 300 psi non-shock WOG with renewable bronze disc.

D. Compressed Air:

1. Shutoff Valves:

   a. Provide two-piece, full port, bronze ball valve with bronze trim and soldered ends, MSS SP-110, 600 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, bronze stem, brass ball with hard chrome plate, and blowout-proof stem. Valve shall be cleaned, capped and delivered certified for "Oxygen Service" from the manufacturer. Manufacturers: Nibco S-585, Apollo series 77, or approved equal.

   b. Provide as specified in Section 22 XX XX.

2. Pressure Regulators: Provide pressure regulator with pressure gauge, adjustable from 10 to 120 psi, at compressed air point of connection to laboratory. Manufacturers: Norgren Excelon 73, Watts R10, or approved equal.

E. Laboratory (Natural) Gas:

1. Shutoff Valves:

   a. Provide conventional port, brass ball valve with brass trim and threaded ends, 400 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, brass stem, brass ball with hard chrome plate. Quarter-turn (closed to fully open) design, yellow vinyl-coated steel
leverage handle requiring less than 5 lbs pressure to operate. Ball valves shall be in compliance with NFPA 54, UL listed and AGA/CGA certified for natural gas service. Manufacturers: Nibco, Apollo, or approved equal.

b. Provide as specified in Section 22 XX XX.

2. Zone Shutoff Valve Box:

a. Provide recessed zone valve box assembly consisting of the following components: minimum 18-gauge welded steel recessed valve box with a baked white enamel finish; anodized aluminum frame assembly; opaque white window with pulling ring assembly to allow easy removal and reinstallation of window. Approximate recessed dimensions: 12-inch wide x 12-inch high x 4-inch deep.

1). Identification:

a). Zone Valve Box: Silkscreen window marking "LABORATORY GAS CONTROL VALVE", "CLOSE ONLY IN EMERGENCY" on the top half of the valve box door and "PULL RING FOR ACCESS" below window pull ring assembly.

b. Manufacturers: Amico Corporation model Alert-1 (less valve and pipe stubs) or approved equal.

F. Specialty Gases:

1. Application:

a. Nitrogen (N₂)

2. Shutoff Valves: Provide three-piece, full-port, bronze ball valve with stainless-steel trim and soldered ends, MSS SP-110, 600 psi CWP rating, 150 psi SWP rating, PTFE or TFE seats, stainless steel stem and ball (vented), blowout-proof stem. Valve shall be cleaned, capped and delivered certified for "Oxygen Service" from the manufacturer. Manufacturers: Nibco S-590, Apollo series 82, or approved equal.

2.3 MANIFOLDS

A. Manufacturers: Products, which comply with this specification section as judged and approved by the Owner’s representative, may be provided by the following manufacturers. All products specified in this section shall be the provided by a single manufacturer.
4. Or approved equal

B. Semi-Automatic Cylinder Manifold System Assembly for Multiple Cylinders:

1. Application:
   a. Nitrogen (N₂)

2. General: Provide semi-automatic changeover assembly for continuous supply of gas from active and reserve cylinder banks. Dual-stage regulator assembly consisting of inlet regulator, selector knob, line regulator, accessories, and mounting plate. Assembly shall be complete and ready for use upon cylinder hookup. Inlet pressure rating of 3,000 psig; assembly line delivery pressure range 0 – 125 psig (unless otherwise noted).

3. Regulator: High purity diffusion resistant type regulator, brass body, nickel-plated brass bonnet, Type 316 stainless steel diaphragm, Teflon or Kel-F seats, metal-to-metal seals on the diaphragm.
   a. Regulators for halogenated corrosive gases shall have Hastelloy internal components.
   b. Provide sub-atmospheric regulator for gases with low operating vapor pressure.
   c. Provide gas heater for CO₂ regulators and other gases subject to excessive cooling.

4. Check Valves: Check valves shall be integral to the CGA connection, Type 316 stainless steel, and furnished with Viton O-rings.

5. Gauges: Bourdon tube type, brass construction, 2-Inch face for inlet and outlet pressures. Accuracy ±2% of full scale. Inlet pressure: 0 – 4,000 psig range. Outlet pressure: 0 – 200 psig or 1.25 times system operating pressure. Changeover assembly shall include pressure gauges to indicate pressures for service bank, reserve bank, and delivery.

6. Relief Valve: Seat-type relief valve, brass housing with Teflon-coated Viton O-ring and adjustable setting.

7. Isolation Valve: Forged brass, high purity packless diffusion resistant diaphragm valve with multi-turn handle. Provide at outlet, inlets to allow isolation of either side of the changeover assembly, and at each cylinder connection.

8. Manifold Piping: Install manifold headers consisting of 7/8-inch seamless brass tube rated for 3,000 psig with individual station isolation valves. Provide brass tees and couplers.
9. Flexible Hose Inlet Assembly: Stainless steel dual braid flexible hose pigtail with brass multi-turn inlet isolation valve and a CGA cylinder connection with integral check valve rated for 3,000 psig working pressure. Provide one inlet hose assembly for each connected cylinder.

10. Mounting Plate: Manifold assembly shall be attached to an anodized aluminum or stainless steel mounting plate (No. 4 finish or better), functionally labeled, pre-drilled and ready for wall mounting.

11. Pressure Switch: Switch senses decreasing cylinder pressure to activate alarm; non-powered, single-pole, double-throw, 125 vac, 5 amp, 60 Hz. Provide required conduit, power and wiring for system operation.

12. Entire assembly helium leak checked to $1 \times 10^{-6}$ scc/sec out board with a mass spectrometer. Dead end pressure tested for 12 hours creep test.

13. Alarm Annunciator Panel: Provide alarm annunciator panel equipped with red (alarm) and green (normal) system status lights, minimum 80 dB audible alarm, audible alarm silence button, and test button. Panel shall include power cord to plug into a 120vac 60 Hz electrical supply receptacle and be equipped with integral 120vac/24vac step-down power transformer as required. Provide permanent engraved labeling to identify alarm channel gas nomenclature. Provide single-channel panel for a single monitored cylinder or multi-channel panel for multiple monitored gas cylinders arranged adjacent to each other.

2.4 PROTECTIVE PIPE COVER (AT EXPOSED P-TRAP ARMS)

A. Manufacturers: Products, which comply with this specification section as judged and approved by the Architect, may be provided by the following manufacturers. All products specified in this section shall be provided by a single manufacturer.

2. Approved equal

B. Basis of Design: Truebro LAV GUARD undersink protective pipe cover.

C. Description: Flexible, molded, antimicrobial, closed cell vinyl pipe cover and fittings for P-trap, angle valve, tailpiece, extension arm, supply tube, etc. components below sink.

D. Material Characteristics:

1. Wall thickness: 1/8 inch (3 mm)
2. Durometer: 60 – 70 Shore A
3. Finish: Smooth high gloss
4. Color: White
5. UV Protection: Will not fade or discolor
6. Flame Characteristics (ASTM D 635): 0 sec. (ATB), 0 mm (AEB)
7. Thermal conductivity (K value): 1.17 plus dead air space

E. Features:

1. Fasteners: Reusable snap clips
2. Protective wrap shall install without disassembling plumbing
3. Latching covers to access angle stops
4. Removable cleanout nut for servicing

2.5 INSULATION

A. Insulate laboratory piping as specified in Section 22 XX XX for the respective systems.

2.6 PIPING HANGERS, SUPPORTS AND GUIDE

A. Provide hangers and supports as specified in Section 22 XX XX.

PART 3 - EXECUTION

3.1 CONNECTION

A. Connect laboratory piping to P.O.C. valves shown on Plumbing drawings and to laboratory services. Provide threaded couplings at final connection to service fittings and valve stops.

B. Laboratory Waste and Vent:

1. Laboratory Waste: Connect laboratory fixture/outlet waste to P.O.C. of laboratory waste. Extend piping from tail piece connector with trap and trap arm,
2. Laboratory Vent: Connect fixture trap arm to P.O.C. of laboratory vent.

3.2 INSTALLATION

A. Domestic and Industrial Cold, Hot, and Tepid Water:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings. Provide threaded couplings at final connection to service fittings and valve stops.
2. Install approved pressure regulators on laboratory equipment connections when required by equipment manufacturer. Set delivery pressure within equipment manufactures’ specifications.
3. Install water hammer arrestors on water piping that serves quick closing or solenoid operated valves for equipment or laboratory services. Water
hammer arrestors shall be installed upstream of these valves in accordance with manufacturer's recommendations.

4. Fixture Connection: Install supply stop valve for each service to fixture as indicated on LP-series drawings. Install flexible connector or flexible tubing from valve to fixture supply water connections.

5. Extend tepid domestic water piping from P.O.C. to drench hoses and safety shower/eyewash units as indicated on LP-series drawings.

6. Refer to corresponding sections of Division 22 for system cleaning and disinfecting requirements.

B. Purified Water:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings.

2. Fixture Connection: Install supply shutoff valve for each fixture as indicated on LP-series drawings. Install flexible tubing from valve to fixture supply water connection.

3. Cleaning:

   a. Refer to corresponding sections of Division 22 for system cleaning and disinfecting requirements.

   b. If not specified elsewhere, minimum requirements shall be to flush and disinfect new water lines with “MINNCARE” or equal cleaning solution.

C. Vacuum:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings.

2. Fixture Connection: Install flexible connector from piping to fixture connection as indicated on LP-series drawings.

3. Cleaning:

   a. Refer to corresponding sections of Division 22 for system cleaning requirements.

D. Compressed Air:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings.

2. Fixture Connection: Install flexible connector from piping to fixture connection as indicated on LP-series drawings.

3. Copper Tubing Brazing Procedures:

   a. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-
copper joints shall be brazed using a copper–phosphorus–silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8 Specification for Brazing Filler Metal. Residual flux on interior surfaces of tubing and fittings must be completed removed with cleaning processes.

b. While being brazed, all piping joints shall be continuously purged with oil-free, dry Nitrogen to prevent the formation of copper oxide on the inside surfaces of the joint. The purge shall be maintained until the joint is cool to the touch.

E. Natural Gas:

1. Extend piping from P.O.C. to services as indicated on LP-series drawings.
2. Fixture Connection: Install flexible connector from piping to fixture connection as indicated on LP-series drawings.
3. Installation Standards: Install gas piping in accordance with recommendations of NFPA 54.
4. Install in-line shutoff valves at locations and per details shown on LP-series drawings.

F. Laboratory Waste and Vent:

1. Install horizontal pipe with uniform slope of 1/4-inch per foot (minimum).
2. Use reduction fittings, not bushings, to connect pipes of different diameters.
3. Change direction by appropriate use of 45-degree wyes, long sweep quarter-bends, and sixteenth-bends.
4. All fixture traps shall be of the "P" type with mechanical joints for removal.
5. No vent shall intersect another vent at a point less than six inches above the extreme overflow level of the highest fixture served unless said fixtures are located back to back, in which a sanitary "TEE" may be used.
6. Vents shall be taken off the top half of horizontal runs and shall be graded so as will quickly drain any water or condensate.

G. Specialty Gases:

1. Application:
   a. Nitrogen – (N₂)

2. Provide and install pressure regulators and cylinder manifolds where shown on drawings.
3. Provide piping from cylinder manifold systems within laboratory room to services as shown on LP-series drawings. Provide threaded couplings at final connection to service fittings.

4. Install service fittings as shown on drawings.

5. Copper Tubing Brazing Procedures:
   a. Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1000°F). Copper-to-copper joints shall be brazed using a copper–phosphorus–silver brazing filler metal (BCuP series) without flux. Flux shall only be used when brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. Brazing alloy comply with ANSI/AWS A.5.8 Specification for Brazing Filler Metal. Residual flux on interior surfaces of tubing and fittings must be completed removed with cleaning processes.
   b. While being brazed, all piping joints shall be continuously purged with oil-free, dry Nitrogen to prevent the formation of copper oxide on the inside surfaces of the joint. The purge shall be maintained until the joint is cool to the touch.

6. Cleaning:
   a. General: All tubing, fittings, and valves shall be delivered to the site cleaned, capped, and protected. If contamination occurs, the item shall be replaced at no additional cost to the Owner. Mass cleaning and/or re-cleaning on site will not be permitted. Cleaning components on site shall be restricted to that required when tubing is cut. Items shall be cleaned in strict compliance with the provisions of the purity level of the piping system. Valves and fittings which become contaminated shall be replaced at no cost to the Owner.
   b. General Purity Specialty Gases: Items shall be cleaned by the supplier in strict compliance with the provisions of "Oxygen" services.

3.3 TESTS

A. Contractor shall thoroughly test all Work prior to operation in the presence of Owner's Representative. Any Work showing faults under test shall be replaced. Contractor shall maintain an accurate written record of all tests and test results, and shall submit three copies of all final tests to the Owner's Representative.

B. Refer to Division 22 specifications for system test requirements. If not specified elsewhere, minimum requirements shall be as follows:
1. Domestic Cold, Hot, and Tepid Water: Test under a cold water hydrostatic pressure of 1-1/2 times operating pressure (150 psig minimum) for a period of four hours and carefully check for leaks. Repair all leaks and re-test system until proven watertight with no loss of pressure or leakage allowed.

2. Purified Water: Do not conceal any piping until satisfactorily tested. Test and prove tight under a hydrostatic pressure of 150 psi for a period of 4 hours and carefully check for leaks. Repair all leaks and re-test system until proven watertight with no loss of pressure or leakage allowed.

3. Laboratory Vacuum: Test and prove airtight under an air pressure of 50 psig for a period of four (4) hours and bubble test all joints with a soap solution. Following pressure test, perform vacuum hold test pressure of -25” Hg for a period of four (4) hours with a maximum vacuum degradation of 1.25” Hg allowed. Repair all leaks and re-test system until proven airtight.

4. Laboratory Air: Test and prove airtight under an air pressure of 150 psig for a period of four (4) hours and bubble test all joints with a soap solution. Repair all leaks and re-test system until proven airtight with no loss of pressure or leakage allowed.

5. Natural Gas: Test and prove gas-tight under an air pressure of 50 psig for a period of four (4) hours and bubble test all joints with a soap solution. Repair all leaks and re-test system until proven gas-tight with no loss of pressure or leakage allowed. Make a final 24-hour standing pressure test with air at 20 psig before connecting equipment. Retest the system until it is proven free of leaks.

C. General Purity Specialty Non-toxic, Non-Flammable Gases:

1. General:
   a. Prior to testing operation, open valves and blow out pipelines to remove foreign matter.
   b. Perform testing in presence of the Owner’s Representative.
   c. Use 99.995% purity Nitrogen for purging and for pressure and leak testing.
   d. Observe safety procedures at all times.
   e. Use gauges cleaned for “Oxygen” service.

2. Pressure Tests:
   a. Nitrogen Pressure Test: The line shall be pressure-tested at 200 psig or 1-1/2 times the operating pressure (whichever is higher) for 24 hours. The line pressure shall be monitored and corrected for ambient temperature.

3. Leak Tests:
a. Nitrogen Pressure Test: The line pressure shall be brought up to test pressure. Perform bubble test of all joints with a soap solution. Repair all leaks and re-test system until proven gas-tight with no loss of pressure or leakage allowed.

END OF SECTION 222000
SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED WORK

A. General Conditions

B. Special Conditions

C. Supplementary General Conditions

D. Architectural, Structural, Civil, Electrical and Mechanical Drawings & Specifications

1.2 SCOPE OF WORK

A. The work covered by the Mechanical Sections of the Specifications shall include the furnishing of all materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of all mechanical and plumbing work required in the Contract Drawings.

B. It is the intent of the Contract Documents to provide an installation complete in every respect. In the event that additional details or special construction is required for work indicated or specified in this Section or work specified in other sections, it shall be the responsibility of the Contractor to provide all material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.

C. The Contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field. The Contractor shall advise the Architect of any discrepancy prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions, and the inclusion of all considerations for existing conditions.

1.3 PLANS AND SPECIFICATIONS

A. These Specifications are accompanied by drawings of the building and details of the installations indicating the locations of equipment, piping, ductwork, outlets, etc. The drawings and these specifications are complementary to each other, and what is required by one shall be as binding as if required by both.
B. If departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Architect for review. No departures shall be made without prior written acceptance of the Architect.

C. The interrelation of the specifications, the drawings, and the schedules is generally as follows: The specifications determine the nature and setting of the materials, the drawings establish the quantities, dimensions, and details, and the schedules give the performance characteristics.

D. Should the drawings disagree in themselves or with the specifications, the contractor shall immediately notify the architect and shall perform and/or furnish the better quality or greater quantity of work or materials unless otherwise directed by the architect in writing. In case the specifications should not fully agree with the schedules, the latter shall govern. Figures indicated on drawings govern scale measurements and large scale details govern small scale drawings. In case of disagreement between specifications and drawings, see Division I of these specifications for clarifications.

E. Items specifically mentioned in the specifications but not shown on the drawings and/or items shown on the drawings but not specifically mentioned in the specifications shall be installed by the Contractor under the appropriate section of work as if they were both specified and shown.

1.4 QUALITY ASSURANCE

A. All work shall comply with the applicable rules of the following:

1. 2006 International Building Code
2. 2006 International Mechanical Code
3. 2006 International Plumbing Code
4. 2006 International Fire Code
5. 2006 International Energy Conservation Code
6. National Fire Protection Association Codes
7. State Fire Marshall
9. All applicable city, county, state, and federal rules, codes, and ordinances.

B. In any instance where these specifications call for materials for construction of a better quality or larger size than required by the codes, the provisions of these specifications shall take precedence. None of the terms or provisions of this specification shall be construed as waiving any rules, regulations, or requirements of these authorities. The codes shall govern in case of direct conflict between the codes and the Drawings.

1.5 SUPERVISION

A. A competent foreman or superintendent, initially approved by the Architect, shall be assigned to the project to receive instructions and to act for the Contractor. Once this superintendent has been approved, no change shall be made without approval of the Architect. Architect's authorized representative and/or owner's observer shall have the right to observe the work at any time. The Contractor shall have a representative present when his work is being observed, and he shall give assistance, as may be required, to the Architect's representative. Recommendations made by the observer shall be promptly carried out, and all unsatisfactory material and/or workmanship shall be replaced at once, to the satisfaction of the Architect.

1.6 GUARANTEE

A. The Contractor shall guarantee all materials and workmanship for a period of two (2) years after the final acceptance of work.

1.7 UTILITIES

A. The contract documents reflect the general location, size, and elevations of sewer line, location, size and pressure of water and other lines and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site, meet with the local utility companies in order to coordinate and confirm the exact requirements for each utility to provide a complete and operative system. The bid submitted by the Contractor shall include costs for all such utility company charges and/or fees.

1.8 BUILDING CONSTRUCTION AND LAYOUT OF WORK

A. It shall be the responsibility of the Contractor to consult the architectural and engineering drawings and details so as to thoroughly familiarize himself with the type and quality of construction to be provided on this project.
B. The Drawings are diagrammatic in character and cannot show every connection in detail or every pipe and duct in its exact location. These details are subject to the requirements of ordinances and also structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be laid out so that it will be concealed in furred chases or above suspended ceilings, etc., in finished portions of the building, unless specifically noted or indicated to be exposed. Work shall be installed to avoid crippling of structural members; therefore, inserts to accommodate hangers shall be set before concrete is poured, and proper openings through floor, walls, beams, etc., shall be provided as hereinafter specified or as otherwise indicated or required before concrete is poured. All work shall be run parallel or perpendicular to the lines of the building unless otherwise noted.

C. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details in regard to location. Exact locations are to be determined by actual measurements at the building and will in all cases be subject to the approval of the Architect, and he reserves the right to make any reasonable changes in the locations indicated without additional cost.

1.9 SHOP DRAWINGS AND BROCHURES

A. After the Contract is awarded, but prior to proceeding with the Work, the Contractor shall obtain, check, certify, and submit complete Shop Drawings and Brochures from Manufacturers, Suppliers, Vendors, etc., for all materials and equipment specified herein. Submit Shop Drawings and Brochures in sufficient time so as not to impede the progress of work. At least two weeks will be required for the processing of Shop Drawings and Brochures in the Engineer's office, exclusive of transmittal time. This time shall be considered by the Contractor when scheduling submittal data.

B. The Engineer's review of Shop Drawings and Brochures shall not relieve the Contractor of the responsibility for dimensions, errors that may be contained therein, or deviations from Contract Document requirements. It shall be clearly understood that the Engineer's noting some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the Shop Drawings, the requirements of the Contract Documents shall govern and are not waived or superseded in any way by the submittal data review.

C. Each Shop Drawing shall indicate in the lower right hand corner and each Brochure shall indicate on the front cover the following: the Title of the Sheet or Brochure; name and location of the building; names of the Architect, Engineer, Contractor, Manufacturer, Supplier, Vendor, etc., the date of submittal; and the date of each correction and revision. So far as is practical, each Shop Drawing and/or Brochure shall bear a cross-reference note to the sheet number or numbers of the Contract
Drawings and/or Specifications showing the same work. Shop Drawings and Brochures shall be prepared as follows:

1. Shop Drawings: Drawings shall be drawn to a scale that can be easily read and shall contain sufficient plans, elevations, sections, and isometrics to describe clearly the items in question. Drawings shall be prepared by skilled technicians experienced in this type of work. All piping, equipment layouts, ductwork and similar Shop Drawings shall be drawn to at least 1/4" = 1'0" scale.

2. Brochures: Brochures shall be published by the Manufacturers and shall contain complete and detailed engineering and dimensional information to show that the equipment will fit into the allotted space. Brochures not compiled in the manner described below shall be returned for resubmittal.

3. Brochures submitted shall contain only information which is relevant to the particular equipment or materials to be furnished. Do not submit catalogs that describe several different items other than those items to be used unless all irrelevant information is marked out or relevant information is clearly marked.

D. The submittal format shall follow the Specifications format with a submittal required for each section of Division 15. Each major category of equipment such as fans or pumps or air devices being submitted under a separate cover letter. The first submittal shall be accompanied by a three-ring hard back binder for the A/E to use in retaining copies of the submittals. Copies of each submittal shall be three-hole punched and arranged (or folded if required) for the A/E's filing convenience. Provide one copy of updated TABLE OF CONTENTS and progressive-tabbed manila index sheets also for the A/E's filing convenience.

E. Submit six (6) copies of all Shop Drawings and Brochures for review and approval. One set will be retained by the Engineer, one set by the Architect for record purposes.

F. Minimum size of submittal data shall be 8-1/2" x 11".

G. Any submittal that is disapproved must be resubmitted within two (2) weeks following notification of such disapproval. If no satisfactory material is submitted within the two-week period, the Architect reserved the right to require the Contractor to furnish items exactly as described in the Contract Documents.

H. No allowances will be made for submittals which are not made in a timely fashion or which are turned down because they are not equal. Should delivery problems arise due to the above, affecting the completion time of the project, the Contractor will
furnish and install acceptable alternates until the proper materials arrive and then replace the alternate materials with the approved materials, all at no cost to the Owner. If the Contractor is not able to furnish an acceptable alternate until the proper materials arrive, he will assume all costs for furnishing and installing all alternates as directed by the Architect and/or will pay a suitable penalty for the inconvenience experienced by the Owner. This penalty will be set by the Architect based on the particular circumstances.

1.10 SUBSTITUTIONS

A. The listing of product manufacturers, catalog numbers, etc., in the various sections of the specifications is intended to establish a standard of quality only, and is not intended to preclude open, competitive bidding. The Contractor may at his option submit substitute materials or methods which he feels are equal or superior to those specified. If the Contractor does submit alternate materials or methods, it shall be understood that the Contractor:

1. Has personally investigated the proposed substitute product and determined that it has all the same accessories and is equal or superior in all respects to the item specified.

2. Will provide the same guarantee for the substitution that he would for that specified.

3. Has coordinated the installation of the equipment which he proposes to substitute with all other trades especially in regard to electrical requirements and to operating weights trades and includes the costs for any changes required for the work to be complete in all respects. The Contractor will prepare shop drawings where required by the Architect or where dimensions vary.

4. Waives any and all claims for additional costs related to the substitution.

1.11 SPARE PARTS DATA

A. As soon as practicable after approval of materials and equipment, and, if possible, not later that one months prior to the date of beneficial occupancy, the Contractor shall furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply; a list of parts and supplies that are either normally furnished at no extra cost with the purchase of the equipment or specified hereinafter to be furnished as part of the contract. The foregoing shall not relieve the Contractor of any responsibilities under the guarantee specified.
1.12 RECORD DRAWINGS

A. The Contractor shall keep a set of Drawings of the job, noting daily all changes made in the Drawings in connection with the final installation including exact dimensioned locations of all new and uncovered existing active and inactive utilities outside the building and shall turn over a clean, neatly marked set of sepia reproduceable Drawings showing "as-built" work to the A/E for delivery to the Owner. All underground utilities and services and systems shall be accurately located by the Contractor and dimensioned on the "as-built" Drawings.

1.13 OPERATING AND MAINTENANCE MANUAL

A. Prepare and submit to the Architect for delivery to the Owner an indexed manual with complete technical data for every piece of equipment and material installed under this contract.

1. Complete mechanical submittals as approved by Architect.

2. Manufacturer's installation instruction brochures.

3. Manufacturer's local representative and/or Distributor's name, address and phone number.

4. Manufacturer's operating and maintenance brochures.

5. Manufacturer's internal wiring diagrams.

B. This manual shall include all of the listed data bound into a permanent hard-back binder identified on the cover as "Operating and Maintenance Manual" with additional cover display of the names and location of the Building, the Owner, the Architect, the Engineers, the General Contractor, and the Sub-Contractors installing equipment represented in the brochure.

C. Contents of the Manual shall be grouped in sections according to the various sections of the specifications and shall be listed in a Table of Contents.

PART 2 PRODUCTS

2.1 STANDARDS FOR MATERIALS

COMMON WORK RESULTS FOR HVAC 230500-7
A. All materials, in general, shall conform to the requirements of all agencies of publications hereinbefore specified under the paragraph QUALITY ASSURANCE and shall be listed, inspected, and approved by the Underwriters Laboratories and shall bear the U.L. label where labeling service is available. The label or listing of the Underwriters Laboratories, Inc. will be accepted as evidence that the materials or equipment conform to the applicable standards of that agency. In lieu of this listing, the Contractor may submit a statement from a nationally recognized testing agency indicating that the items have been tested in accordance with required procedures, and that the materials and equipment comply with all contract requirements.

2.2 STANDARD PRODUCTS

A. Materials and equipment to be provided shall be the standard catalog products of manufacturers regularly engaged in the manufacture of products conforming to these specifications, and shall essentially duplicate materials and equipment that have been in satisfactory use at least two years.

2.3 MANUFACTURERS INSTRUCTIONS

A. The responsibility for the furnishing of the proper equipment and/or material and the responsibility for seeing that it is installed as intended by the manufacturer, rests entirely upon the Contractor. If needed for proper installation, operation, or startup, the Contractor shall request advice and supervisory assistance from the representative of the specific manufacturer. The manufacturers' published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. The Contractor shall promptly notify the Architect in writing of any conflict between the requirements of the contract documents and the manufacturers' directions and shall obtain the Architect’s instructions before proceeding with the work. Should the Contractor perform any such work that does not comply with the manufacturers' directions or such instructions from the Architect, he shall bear all costs arising in connection with the deficiencies.

2.4 RUST PREVENTION

A. All metallic materials shall be protected against corrosion. Exposed metallic parts of outdoor apparatus made of ferrous metals but not of corrosion-resistant steel, shall be zinc-coated in accordance with ASTM A123 or A153, except where other equivalent protective treatment is specifically approved in writing.

2.5 STORAGE ON SITE
A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is a suitable space provided to properly protect equipment from rust, weather, humidity, dust, or physical damage.

2.6 CAPACITIES

A. Capacities shall be not less than those indicated and shall be such that no component or system becomes inoperative or is damaged because of startup or other overload conditions.

2.7 NAMEPLATES

A. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.

2.8 CONDITION OF MATERIAL AND APPURTENANCES

A. All pipe, fittings, appurtenances, and other material required for complete installation of these systems shall be new to conform to manufacturer's recommendations, unless otherwise specified. All equipment injured or damaged in transit from factory, during delivery to premises, while in storage on premises, while being erected and installed, and while being tested, until time of substantial completion, shall be replaced by the Contractor without extra cost to Owner.

PART 3 EXECUTION

3.1 INSTALLATION OF SYSTEMS

A. Provide and install unions at proper points to permit removal of pipe and various equipment and machinery items without injury to other parts of system. No union will be required in welded lines or lines assembled with solder joint fittings, except at equipment items, machinery items, and other special pieces or apparatus. Companion flanges on lines at various items of equipment, machines and pieces of apparatus, shall serve as unions to permit removal of the particular items. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.

3.2 SPACE AND EQUIPMENT ARRANGEMENT

A. All equipment shall be installed in a manner to permit access to parts requiring service without disassembly of other equipment.
B. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to permit access through stairways, doorways, or shafts shall be brought to the job and placed in the space before the enclosing structure is completed. Following placement in the space, such apparatus shall be thoroughly protected against damage.

3.3 PRECEDENCE OF WORK

A. This contract includes many different systems furnished and installed by different trades. Each trade shall coordinate their work with that of all other trades so that it may be installed in the most direct and workmanlike manner without hindering or handicapping any other trades.

3.4 CUTTING AND PATCHING

A. Where it becomes necessary to cut through any wall, floor, or ceiling to permit installation of any work under this section of the specifications or to repair any defects that may appear, up to the expiration of the guarantee period, such cutting shall be done under the observation of the Architect by the Contractor. The Contractor shall not be permitted to cut or modify any structural members without the written direction of the Architect.

B. Patching of all openings cut by the Contractor, or repairing of any damage to the work of other trades occasioned by the cutting operations, or occasioned by the failure of any part of work installed under this contract, shall be performed by the trade whose work is involved, but shall be paid for by the Contractor.

C. Any openings cut through exterior walls or roofs shall be provided with suitable covers, while they are left open, to protect the property or materials involved. Any openings cut through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.

3.5 HOISTING, SCAFFOLDING, AND TRANSPORTATION

A. The Contractor shall provide his own hoisting facilities to set his materials and equipment in place in the building, as indicated on drawings and for subsequent cleaning, testing, and adjusting.

B. The Contractor shall provide necessary transportation to facilitate the delivery of all materials, equipment, tools, and labor to the job, in accordance with intent of these documents.
3.6 CLEANING

A. The Contractor shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by him, his employees, or his work. This debris shall be removed, not only from the building, but also from the project site.

B. At completion of the job, the Contractor shall remove all of his tools, scaffolding, and surplus materials. He shall leave the area "broom clean."

3.7 ELECTRICAL WIRING OF MOTORS AND EQUIPMENT

A. Unless specifically shown, indicated, or specified to the contrary, each item shown or required by the Drawings or specified in the Specifications shall be accompanied by all motors and starting and controlling equipment necessary for the items' proper operations. These motors shall be integrally attached to and/or installed with their associated equipment item and electrically connected as specified in the Electrical Specifications. Equipment controlled from motor control centers shall be supplied with motors only. Motor control centers are specified in the Electrical Specifications and shown on the Electrical Drawings.

END OF SECTION
SECTION 230519 - PIPING SPECIALTIES

PART 1  GENERAL

1.1  WORK INCLUDED

A.  Escutcheons

B.  Strainers

C.  Dielectric Unions

D.  Air Vents

E.  Pressure Relief Valve

F.  Thermometers

G.  Pressure Gauges

1.2  RELATED WORK

A.  Section 230500 – Common Work Results for HVAC

B.  Section 230529 - Supports, Anchors & Sleeves for Plumbing

C.  Section 230523 – Valves for HVAC

D.  Section 232113 - HVAC Piping Systems

1.3  SUBMITTALS

A.  Submit manufacturer's product and dimensional data in accordance with Section 230000 Heating, Ventilating & Air Conditioning.

PART 2  PRODUCTS

2.1  ESCUTCHEONS

A.  Escutcheons shall be chrome plated sectional type. Solid type escutcheons with set screws shall be used when sectional type are not available of adequate size or where sectional type will not stay in place.
2.2 STRAINERS

A. Strainers shall be Y-Pattern the same size as the pipe in which they are installed, threaded or flanged as indicated by pipe size. An arrow shall be cast on the side of the strainer to indicate the direction of flow. The basket shall be made of stainless steel or monel and shall provide a net free area through the basket of at least four times that of the pipe in which the basket is installed up to a maximum of 20 mesh.

B. Strainers for water services shall have a cast iron body, an easily removable cover and a sediment screen. Cover shall have threaded 3/4" blow-off port.

C. Strainers shall be RP&C, Hoffman, B&G, O.C. Keckley or approved equal.

2.3 DIELECTRIC UNIONS

A. Unions shall be threaded or flanged type as dictated by the size of the piping. High temperature type insulating fittings shall be provided where required. Unions shall be EPCO or approved equal.

2.4 AIR VENTS

A. All air vents required in the hot water circuit shall be of the ball and float type, cast iron body, stainless steel internals, Metraflex MV-15, Armstrong Pumps or V.O. Anderson 70A.

B. Air vents shall be 3/4" screwed pattern valves suitable for 150 psig maximum working pressure. The vent shall be suitable for both hot and cold water service.

2.5 PRESSURE RELIEF VALVE

A. Provide a pressure relief valve on all closed loop chilled water and heating water systems as follows:

1. ASME stamped.

2. Cast iron body with bronze trim.

3. Set to relieve at 30 psig unless higher pressure required due to operating pressures involved.
2.6 THERMOMETERS AND THERMOMETER WELLS

A. Provide 9 inch, aluminum case, brass stem, (aluminum stem in submersible wells), adjustable angle, mercury red reading type thermometers where shown on the drawings.

B. Provide brass separable sockets of the correct length for the pipe size in which they are installed. Provide with extension necks when installed in insulated piping.

C. Ranges shall be as follows:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Heating Water</td>
<td>0°F to 240°F</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>0°F to 100°F</td>
</tr>
</tbody>
</table>

D. Brass industrial test wells, 3/4" N.P.T., with cap and chain. Test wells shall be the correct length for the pipe size in which they are installed.

E. Thermostats shall be Trerice, Weksler or approved equal.

2.7 PRESSURE GAUGES

A. Provide 4-1/2" inch dial, bourdon type pressure gauges where shown on the drawings.

B. Case shall be cast aluminum with black finish.

C. Gauges shall have adjustable pointer and bronze movement with 1 percent accuracy over middle half of scale range and 1-1/2 percent accuracy over the balance of the range.

D. Gauges shall have brass socket and be provided with brass pressure snubbers.

E. Ranges shall be as follows:

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<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled &amp; Heating Water</td>
<td>0 to 100 psi</td>
</tr>
</tbody>
</table>

F. Pressure gauges shall be Trerice, Weiss, Weksler or approved equal.
3.1 INSTALLATION

A. All strainers, air separators, suction diffusers, backflow preventers and pressure reducing valves shall be full line size unless noted otherwise.

3.2 ESCUTCHEONS

A. Escutcheons shall be installed around all pipes passing exposed in finished areas through walls, floors and ceiling. Escutcheons shall be sized to fit tight around the outside of the pipe or pipe insulation.

3.3 STRAINERS

A. Each control valve, and pressure reducing valve assembly regardless of its size shall be preceded by a strainer. The arrangement of these strainers shall be such that the screens may be removed for cleaning.

B. Strainers shall be installed in piping systems wherever shown on the drawings and at such other points as may be required for the removal of foreign material from the piping system.

C. All strainers shall be provided with full size blowdown ball valve with nipple and cap.

3.4 DIELECTRIC UNIONS

A. Install dielectric unions or flanges where copper or brass piping connects to ferrous piping or equipment.

3.5 AIR VENTS

A. Install automatic air vents at all high points in the chilled and heating water systems with overflows piped to the nearest drain.

3.6 THERMOMETERS AND THERMOMETER WELLS

A. Install thermometers with scales upright and in a location where they may be easily read.

B. Install thermometer wells where shown and where required to test and adjust the system.

C. Replace any damaged thermometers. Do not repair.
3.7 PRESSURE GAUGES

A. Provide gauge cocks or needle valves at all gauges suitable for the pressures and service involved.

B. Replace any damaged gauges. Do not repair.
SECTION 230523 - VALVES FOR HVAC

PART 1  GENERAL

1.1  WORK INCLUDED

A. Gate Valves
B. Ball Valves
C. Globe Valves
D. Check Valves
E. Butterfly Valves
F. Balancing Valves

1.2  RELATED WORK

A. Section 230500 – Common Work Results for HVAC
B. Section 232113 - HVAC Piping Systems

1.3  SHOP DRAWINGS

A. Submit product data in accordance with Section 15010.

PART 2  PRODUCTS

2.1  ACCEPTABLE MANUFACTURERS

A. Valves as manufactured by KITZ, Nibco, Crane, Apollo, Watts or approved equal are acceptable provided they meet or exceed these specifications.

B. Provide valve types of same manufacturer throughout where possible.

C. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

D. Provide factory-fabricated valves recommended by manufacturer for use in service indicated. Provide valves of types and pressure ratings indicated; provide proper selection as determined by installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube.
and equipment connections. Where more than one type is indicated, selection is Installer's option. Valves shall be of same make for all these services.

2.2 VALVE CONNECTIONS

A. Provide valves suitable for connection to adjoining piping as specified for pipe joints. Use pipe size valves unless otherwise indicated.

B. Provide threaded valves for pipe sizes 2 inches and smaller.

C. Provide flanged valves for pipe sizes 2 1/2 inches and larger.

D. Solder or screw to solder adaptors for copper tubing.

E. Use valve body suitable for mechanical coupling jointed piping.

F. Provide butterfly valves with full tapped lug bodies.

2.3 GATE VALVES

A. Select valves, equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower. Guides for disc on rising stem valves must be machined for accurate fit.

B. Comply with the following standards:

   Cast Iron Valves: MSS SP - 70
   Bronze Valves: MSS SP - 80

D. HVAC Water Service

   1. Threaded ends 2" and smaller: Class 125, bronze body, union bonnet, rising stem, solid wedge: Kitz #42, Nibco T-124/134, Crane 431UB or equal.

   2. Solder ends 2" and smaller: Class 150, bronze body, union bonnet, rising stem, solid wedge: Kitz #43, Nibco S-134 or equal.

   3. Flanged ends 2-1/2" and larger: Class 125 iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Kitz #72, Nibco F617-0, Crane 465-1/2 or equal.
2.4 GLOBE VALVES

A. Select valves equipped with packing suitable for intended service. (Under no circumstances is asbestos acceptable) Select valves designed so back seating protects packing and stem threads from media when valve is fully opened, and equipped with gland follower.

B. Comply with the following standards:

- Cast Iron Valves: MSS SP - 85
- Bronze Valves: MSS SP - 80

C. HVAC Water Service

1. Threaded ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, bronze disc: Kitz #11, Nibco T-211-B, Crane 1 or equal.

2. Solder ends 2" and smaller: Class 125, bronze body, screwed bonnet, rising stem, bronze disc (swivel type): Kitz #12, Nibco S-211-B, Crane 1310 or equal.

3. Flanged ends 2-1/2" and larger: Class 125 iron body, bolted bonnet, rising stem, OS&Y, renewable seat and disc: Kitz #76, Nibco F718-B, Crane 351 or equal.

2.5 BALL VALVES

A. Select with full port opening, blow out proof stem, hard chrome plated forged brass vented ball, adjustable packaging nut, rated not less than 600# W.O.G., 150 W.S.P.

B. Comply with the following standards:

- Ball Valves: MSS SP - 110

C. HVAC Water Service

1. Threaded ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem: Kitz #68, Nibco T-585-70, Apollo 77-100 Series, Watts B-6080 or equal.

2. Solder ends 3" and smaller: 600# W.O.G., 150 W.S.P., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing
nut, blow-out proof stem: Kitz #68, Nibco T-585-70, Apollo 77-200 Series, Watts B-6081 or equal.

D. Natural Gas Service

1. Threaded ends 2" and smaller: 175# W.O.G., bronze two piece body, hard chrome plated full port forged brass ball, true adjustable packing nut, blow-out proof stem, U.L. listed for natural gas service: Kitz #60, Nibco GB, Watts GBV or equal.

2.6 BUTTERFLY VALVES

A. Where butterfly valves are used as shut-off for termination, or equipment removal or repair, select ductile iron lug type valves, bi-directional, dead-end service rated to the full working pressure of the valve. Provide gear operators on butterfly valves 8" and larger. Valve bodies to have extended necks to provide for 2-1/2" insulation as needed. Butterfly valves 12 inch and smaller rated to 200 psi, 14 inch and larger to 150 psi.

B. Comply with the following standards:

Butterfly Valves: MSS SP - 67

C. HVAC Water Service

1. Lug type 2" and larger: Ductile iron body, lever operated, 10-position throttling handle 2-6 inch, 8 inch and larger gear operated, bronze disc, type 400 Series stainless steel stem, EPDM seat. Butterfly valves 12 inch and smaller rated to 200 psi, 14 inch and larger 150 psi.

D. Manufacturer subject to compliance with requirements, provide butterfly valves with one of the following: Kitz #6122E (Lug type), Milwaukee, ML233E (Lug), Nibco LD2000 (Lug) or equal.

2.7 SWING CHECK VALVES

A. Comply with the following standards for design, workmanship, material and testing:

Bronze Valves: MSS SP - 80
Cast Iron Valves: MSS SP - 71

B. Construct valves of pressure casting free of any impregnating materials

C. Domestic Water Service
1. Threaded ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, bronze disc: Kitz #22, Nibco T-413B, Crane 37 or equal.

D. HVAC Water Service

1. Threaded ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, Teflon disc: Kitz #22T, Nibco T-413Y, Crane 141 or equal.

2. Soldered ends 2" and smaller: Class 125, bronze body, screwed cap, "Y" pattern swing, Teflon disc: Kitz #23T, Nibco T-433Y, Crane 37 or equal.

3. Flanged ends 2-1/2" and larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Kitz #78, Nibco F918-B, Crane 373 or equal.

2.8 BALANCING VALVES

A. Manual Balance Valve: Furnish and install as shown on plans, a calibrated (bronze/cast iron with bronze disc) balance valve equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral check valve designed to minimize system fluid loss during the monitoring process. The balancing valve shall have an indexing pointer and calibrated nameplate to indicate the degree of closure of the precision machined orifice. Each balancing valve is to be constructed with internal O-ring seals to prevent leakage around the rotating element. The balancing valves shall be supplied with performed polyurethane insulation, suitable for use on heating and cooling system.

B. Automatic Balance Valves: Furnish threaded or flanged valves with cartridge, bronze or steel housing to match pipe material and pressure and temperature taps. Flow shall be accurate to a +/- 5% within a pressure range of 4 - 55 psi for Areas A,B,C,D & M; 2 - 30 psi for Areas E,F,G & H and 1 - 20 psi for Areas J & K. For flows below 30 gpm, combo valves may be used. Griswold Controls, Auto Flow or Hays valves are acceptable.

2.9 VALVE FEATURES

A. Provide valves with features indicated and where not otherwise indicated, provide proper valve features as outlined in this specification. Comply with ANSI B31.1.


C. Threaded valve ends comply with ANSI B2.1.
D. Solder Joint valve ends complying with ANSI B16.18.

E. Fabricate pressure-containing components of valves, including stems and seats from brass or bronze materials; of standard alloy recognized in valve manufacturing that resist de-zincification.

F. Butterfly valve designed for flow regulation and manufactured to be tight in closed position. Test pressures in accordance with MSS SP-67 as follows: Seat 2-12" 220 psi. No leakage permitted under test.

2.10 VALVE OPERATORS

A. Provide suitable handwheels for gate, globe and butterfly valves.

B. For butterfly valves provide gear operators for sizes 8 inches and larger. For smaller sizes provide lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock nut and memory stop for throttling service.

C. Provide valves located more than 7 feet from floor in equipment room areas with chain wheel operators. Extend chains to about 5 feet above floor and hook to clips arranged to clear walking aisles.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install ball valves for shut-off and isolating service, to isolate equipment, part of systems, or vertical risers.

C. Install globe valves for throttling service and control device or meter by-pass.

D. Provide shut-off valves and check valves on discharge of pumps.

E. Install check valves in horizontal position with pin horizontally perpendicular to center line of pipe. Install for proper direction of flow. Installations on any vertical piping must be up flow only.

F. All valves shall be located so that the bonnets can be removed.

G. Where valves are installed concealed in pipe chases provide Zum Z-1460-4 or approved equal access doors with concealed hinge and key operated locks. Door
shall be large enough to service valves and shall be installed flush with finished walls.

H. Provide brass tag for each valve labeling the fluid in the pipe, the area served, and the normal operating position.

END OF SECTION
SECTION 230529 - SUPPORTS, ANCHORS AND SLEEVES FOR HVAC

PART 1 GENERAL

1.1 WORK INCLUDED

A. Pipe Hangers and Supports
B. Duct Hangers and Supports
C. Flashing for Mechanical Equipment
D. Sleevings for Mechanical Equipment

1.2 RELATED WORK

A. Section 230500 - Common Work Results For HVAC
B. Section 232113 - HVAC Piping Systems
C. Section 233100 - HVAC Ducts

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 230500 – Common Work Results For HVAC.

1.4 REFERENCES

A. Duct Hangers: SMACNA Duct Manuals.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products shall be as manufactured by Grinnell, Elgen, Fee and Mason, Unistrut or approved equal.

2.2 INSERTS

A. Malleable iron case of galvanized steel sheet and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
B. Size inserts to suit threaded hanger rods.

2.3 PIPE HANGERS AND SUPPORTS

A. Hangers: Pipe sizes 1/2 inch to 1-1/2 inch: adjustable wrought steel ring.

B. Hangers: Pipe sizes 2 inches to 4 inches: adjustable wrought steel clevis.

C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

D. Vertical Support: Steel riser clamp.

E. Floor Support for Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.

F. Steel Beam Clamps: Elcen Figure 33, Type 3 or approved equal.

G. Expansion Anchors: Phillips Red Head or approved equal.

H. Design hangers to impede disengagement by movement of supported pipe.

I. Provide copper plated hangers and supports for copper piping or two layers Scotch 33 PVC tape or equal.

2.4 HANGER RODS

A. Provide cadmium plated steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.5 DUCT HANGERS AND SUPPORTS

A. Hangers: Galvanized steel band iron or rolled angle and 3/8 inch rods.

B. Wall Supports: Galvanized steel band iron or fabricated angle bracket.

2.6 FLASHING

A. Steel Flashing: 24 gauge galvanized steel.

2.7 SLEEVES

A. Pipes through Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with galvanized steel pipe.
B. Round Ducts: Form with 18 gauge galvanized steel.

C. Rectangular Ducts: Form with 18 gauge galvanized steel.

D. Size large enough to allow for movement due to expansion and to provide for continuous installation.

PART 3 EXECUTION

3.1 INSERTS

A. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

B. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch or ducts over 60 inches wide.

C. Where concrete slabs form finished ceiling finish inserts, flush with slab surface.

3.2 PIPE HANGERS AND SUPPORTS

A. All structures and appurtenances employed for the purpose of supporting the pipe and guiding it properly shall be carefully fabricated in such a manner as to preserve the true grade of the pipe without subjecting either the pipe or the supporting and guidance members to any undue strain.

B. Support horizontal piping as follows:

C. Space hangers and furnish rods as follows:

<table>
<thead>
<tr>
<th>Nominal Pipe Size (in.)</th>
<th>Span (ft.) Steel</th>
<th>Span (ft.) Copper</th>
<th>Hanger Rod Diameter (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2</td>
<td>5</td>
<td>5</td>
<td>3/8</td>
</tr>
<tr>
<td>3/4</td>
<td>6</td>
<td>6</td>
<td>3/8</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>6</td>
<td>3/8</td>
</tr>
<tr>
<td>1-1/2</td>
<td>9</td>
<td>8</td>
<td>3/8</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>9</td>
<td>3/8</td>
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<td>3</td>
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<td>10</td>
<td>1/2</td>
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<tr>
<td>4</td>
<td>10</td>
<td>10</td>
<td>5/8</td>
</tr>
</tbody>
</table>
D. Install hangers to provide minimum 1/2 inch clear space between finished covering and adjacent work.

E. Place a hanger within one foot of each horizontal elbow.

F. Use hangers which are vertically adjustable 1-1/2 inch maximum after piping is erected.

G. Support piping at each change or direction, at ends of branches, at base and top of riser pipes and drops, and wherever necessary to prevent sag, bending or vibration, in addition to above-listed hanger spacing.

H. Support vertical piping at every floor.

I. Pipe hangers on insulated lines shall be sized to fit the outside of the insulation.

J. Where several pipes can be installed in parallel and at the same elevation, provide multiple or trapeze hangers, designed to support loads per ANSI B31.1.

K. Where practical, support riser piping independently of connected horizontal piping.

3.3 LOW VELOCITY DUCT HANGERS AND SUPPORTS

A. Duct hangers and supports to be sized and spaced as per SMACNA requirements.

3.4 EQUIPMENT BASES AND SUPPORTS

A. Provide for major equipment minimum four inch thick reinforced concrete house-keeping bases poured directly on structural floor slab pinned in place and extended 6 inches minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment. Coordinate with other trades.

B. Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

C. Provide rigid anchors to ducts and pipes immediately after vibration connections to equipment.

3.5 PRIMING

A. Prime coat non-galvanized steel hangers and supports.

3.6 FLASHING

SUPPORTS, ANCHORS & SLEEVES FOR HVAC
A. Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floor and roofs.

B. Provide curbs for mechanical roof installation 12 inch minimum high. Flash and counterflash with steel, soldered and waterproofed.

3.7 SLEEVES

A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

B. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.

C. Where piping or ductwork passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

D. Install chrome plated escutcheons where piping passes through finished surfaces.

E. Provide pipe sleeves for all mechanical piping.

F. Size pipe sleeves to permit placing pipe and specified insulation material for pipes passing through concrete or masonry walls or concrete slabs.

G. Sleeves for pipes through floor slabs standard weight galvanized steel pipe with top of sleeve projecting 2 inches above finished floor. For waterproof sleeves.

H. Sleeves for pipe through walls standard weight galvanized steel pipe or 18-gauge galvanized sheet metal with ends flush with wall surface.

I. Seal pipes passing through walls or slabs. Use mastic or oakum seal in the annular space in non-fire-rated walls; use Dow-Corning 3-6548 silicone RTV foam firestop sealant or equal in the annular space in fire-rated walls or other envelopes.

J. Seal exposed pipe passing through floor slabs with Dow- corning 3-6548 silicone RTV foam firestop sealant or equal and point with caulking compound. Strike off flush at top of sleeve.

K. Insulated pipe shall be insulated in sleeves, caulked and pointed as above.

L. Sleeves penetrating exterior walls below grade shall be standard weight, black steel pipe with 1/4" thick steel plate secured to the pipe with a continuous fillet weld. The
plate shall be located in the middle of the wall and shall be 4" wider all around than the sleeve it encircles. The entire assembly shall be hot dipped galvanized after fabrication. The pipe passing through the sleeve shall be centered within the sleeve and the annulus opening sealed with "Link Seal" casing seals manufactured by Thunderline Corporation, Wayne, Michigan. Series 300 for pipe sizes 1/2" through 10" and series 400 or 500 for larger pipe sizes or equal.

M. Pipe and duct sleeves, pitch pockets, and flashings compatible with the roofing installation shall be provided for roof penetrations.

N. All piping shall be installed with due regard to expansion and contraction. Type of hanger, methods of support, location of supports, etc., shall be governed in part by this consideration.

END OF SECTION
SECTION 230593 - TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.1 WORK INCLUDED

A. Testing, adjusting and balancing of the following systems:
   1. Air Distribution Systems
   2. Exhaust Systems
   3. Domestic Hot Water Systems
   4. HVAC Hydronic System

1.2 RELATED WORK

A. Section 230500 – Common Work Results For HVAC
B. Section 230523 – Valves For HVAC
C. Section 233423 - Power Ventilators
D. Section 233713 - Diffusers, Registers & Grilles
E. Section 237313 – Modular Outdoor Central Station Air Handling Units

1.3 REFERENCED STANDARDS

A. Associated Air Balance Council, AABC National Standards.
B. Applicable SMACNA Standards.
1.4 QUALITY ASSURANCE

A. All work for the testing and balancing of the HVAC air distribution and hydronic systems shall be done by an independent Testing and Balancing firm that specializes in and whose business is limited to the testing and balancing of heating, ventilating and air conditioning systems.

B. If requested, the test shall be conducted in the presence of the Architect and/or the Owner.

C. The environmental systems including all equipment, apparatus and distribution systems shall be tested, adjusted and balanced in accordance with the latest edition of the AABC Procedural Standards for Testing, Adjusting and Balancing of Air Distribution and Hydronic Systems.

D. Instruments used in all HVAC systems and equipment tests shall be as recommended by the AABC, ASHRAE, NEBB, or as approved by the Architect. Test instruments used shall be initially and periodically checked thereafter to verify their calibration accuracy.

E. All test equipment shall be furnished by the Contractor and shall remain in his property. Any adapters such as "Pete's Plugs", pitot tube traverse connections, etc. shall be left in place and marked for future use.

1.5 SUBMITTALS

A. Submit test reports in accordance with Section 230500.

B. Specific procedures used in all tests shall be included in the test report. Contractor shall identify all equipment by the identification code as shown on the drawings.

C. Data shall be on printed forms published by either AABC or the Contractor.

D. The test report shall include as a minimum the following information and data:

1. Motors:
   Equipment number
   Manufacturer
   Model or serial number
   Frame size
   Rated horsepower
   Rate rpm
Corrected full load amperage
Measured amperage and voltage
Calculated bhp
Measured rpm
Sheave size, type and manufacturer

2. Fans:
   Equipment number
   Manufacturer
   Model or serial number
   Rated cfm
   Rated rpm
   Rated pressures
   Measured cfm
   Measured rpm
   Measured pressures
   Pulley size, type and manufacturer
   Belt size and quantity

3. Pumps:
   Equipment number
   Manufacturer
   Model or serial number
   Rated gpm
   Rated head
   Rated pressures
   Final discharge pressures
   Final suction pressures
   Final gpm
   Operating head
   Operating rpm

4. Diffuser, Registers and Grilles:
   System identification
   Grille number
   Grille or diffuser manufacturer
   Manufacturer's model number
   ADC flow factor
   Instrument to be used with ADC flow factor
   Grille size
   Design velocity
   Design cfm
   Final measured velocity
   Final measured cfm
E. All reports shall be certified by the Testing and Balancing Contractor that the methods used and the results achieved are as specified. In addition, each individual reporting form submitted must bear the signature and the Technician.

1.6 GUARANTEE

A. The test and balance firm shall include an extended warranty of 90 days, after the submittal of the test and balance report, during which time the Architect, at his discretion, may request a recheck or resetting of any outlet, supply air fan, exhaust fan, or any other item listed in the test report. The firm shall provide technicians to assist the Architect making any tests he may require during this period of time.

PART 2 PRODUCTS

Not applicable for this section.

PART 3 EXECUTION

3.1 INSPECTION

A. The Testing and Balancing Contractor shall act as an authorized inspection firm responsible to the Architect. He shall review the HVAC design drawings and shop drawings prior to fabrication and installation of the HVAC systems to insure that all of the necessary balancing equipment required to balance these systems is shown.

3.2 PREPARATION

A. Coordinate Schedules with the Test and Balancing Engineer and provide sufficient time before final completion of work so that testing and balancing can be accomplished. Provide all labor and tools to make corrections to the system when required to balance the system without undue delay to the Test and Balancing Contractor. Put all equipment into full operation and continue it in operation during each working day of testing and balancing. No test and balancing work shall start until all of the air handling equipment has new filters installed. The Test and Balancing Engineer shall be kept informed during the construction of the project of major changes made to the HVAC system. Provide the Test and Balancing Contractor with one (1) set of shop drawings on all equipment which he will be required to work on when balancing the HVAC system.

B. Shop drawings shall be submitted to the Test and Balancing Contractor. The Test and Balancing Contractor will, during the construction of the HVAC system, make job site inspections to familiarize himself with the project and shall report to the
Architect items installed incorrectly or not installed in accordance with the contract drawings and specifications.

C. Work shall not begin until all systems which are to be tested have been completed and are in full working order. Put all systems and equipment into full operation and continue the operation of all equipment during each working day of the testing and balancing work.

3.3 AIR DISTRIBUTION SYSTEMS TESTING AND BALANCING

A. Utilizing the latest issue of design documents, compare the installed equipment to the design and check for completeness of the installation.

B. The system and air outlet air quantities shall be balanced to the values indicated on the drawings.

C. The grille manufacturer’s outlet flow factors as determined by the ADC test code and recommended procedure for testing air outlets shall be used.

D. Prebalance equipment check:
   1. Check fan housing, ducts, duct elbows, coils, louvers, etc., to insure they are clean and free of foreign material.
   2. Check filters to insure that they are clean and in place.
   3. Examine drivers for proper belt tension and alignment.
   4. Check fan and motor lubrication.
   5. Coordinate with Electrical Contractor to verify correct motor overload protectors.
   6. Coordinate with HVAC Control Contractor for proper operation and position of operating dampers.
   7. Check fans for proper rotation.

E. Prebalance System Check:
   1. Verify installation of all required balancing dampers. Set all systems dampers in their open position.
2. Check for air leaks at the fan and the system ductwork. Coordinate with the Contractor for repair of leaks.

3. Position all building doors and windows (if a part of system design) in their normal position.

4. Check air temperature to insure required air temperature delivery.

F. Air Handling Equipment Balance:

1. Check motor amperage and voltage to insure motor is not being overloaded.

2. Measure and set minimum outdoor air quantity where applicable.

3. Determine the volume of air being delivered by the fan. Adjust the fan speed, if belt-driven, or the dampers in the system, if direct-driven, to increase or decrease the flow required. If the speed is increased, or the flow changes due to a damper adjustment, insure that the motor is not overloaded.

4. Check fan and motor speed, no-load amperage, operating amperage and voltage. Calculate brake horsepower.

5. Take fan static pressure readings.

6. Variation of air flow for all modes of operation from the design values shall be within +10 percent of design values.

3.4 WATER DISTRIBUTION SYSTEM BALANCING AND TESTING

A. Utilizing the latest issue of design documents, compare the installed equipment to the design and check for completeness of the installation.

B. Prebalance Equipment Check:

1. Check to insure that automatic fill valves are functioning properly.

2. Check pump and motor lubrication, and overload protectors for proper size.

3. Check pump for proper rotation.

C. Prebalance System Check:

1. Set all valves in their wide open position.
2. Check system strainers for cleanliness.

D. Pump Testing and Adjustment:
   1. Determine pump impeller size by plotting no-flow pump differential pressure on pump curve.
   2. Determine water flow by plotting full-flow pump differential pressure on pump curve. Adjust flow to approximately 110 percent of design.
   3. Record motor voltage and amperage and calculate brake horsepower.

E. Water System Balancing:
   1. Determine and set flow rates to insure proper GPM and water supply temperature.

3.5 OTHER EQUIPMENT TESTS

A. All equipment installed shall be tested, adjusted, and reported upon unless stated otherwise. The equipment discussed herein is not necessarily all of the equipment requiring testing.

B. Fans:
   1. Record nameplate data.
   2. Check belt alignment and belt tension.
   3. Measure current, voltage, and speed (rpm)

END OF SECTION
SECTION 230713 - DUCT INSULATION

PART 1  GENERAL

1.1 WORK INCLUDED

A. Duct Thermal Insulation

B. Adhesives, Tie Wires, Tapes

1.2 RELATED WORK

A. Section 230500 – Common Work Results For HVAC

B. Section 233100 - HVAC Ducts

1.3 QUALITY ASSURANCE

A. All insulation materials required for ductwork shall be furnished and installed under the contract. The execution of the work shall be by approved insulation contractor in strict accordance with the best practice of the trade and the intent of the specification.

B. It is mandatory that all insulation be applied in a neat and workmanlike manner. Contractor shall be required to remove and replace all insulation not applied in strict accordance with the manufacturer’s specifications or not presenting a neat finished appearance.

C. The Ductwork insulation shall meet NFPA Standards 902 and 906 for fire resistance.

1.4 SUBMITTALS

A. Submit product data and installation instructions in accordance with Section 230500 – Common Work Results For HVAC.

1.5 REFERENCE STANDARDS

A. NFPA 90A and 90B.

B. ASTM Standard E84-75.

1.6 JOB CONDITIONS
A. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Materials as manufactured by Certain-Teed, Johns-Manville, Knaul, Owens-Comings, Foster Products, Childers or approved equal meeting these specifications are acceptable.

2.2 TYPE AND PERFORMANCE

A. Adhesives and Insulation Materials: Composite fire and smoke hazard ratings maximum 25 for Flame Spread and 50 for Smoke Developed. Adhesives to be waterproof.

B. Round and Rectangular Ducts: Rigid or Flexible fibrous glass insulation, 1 1/2 inch thick "K" value at 75 degrees F maximum 0.26 btu/hr./sq.ft./Deg. F/hr. with factory applied reinforced aluminum foil vapor barrier for temperatures for +40 Deg. F to +250 Deg. F services.

PART 3 EXECUTION

3.1 PREPARATION

A. Do not install covering before ductwork has been tested and approved.

B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 INSTALLATION

A. Ensure installation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material, properly sealed.

B. Finish insulation neatly at hangers, supports and other protrusions.

C. Locate insulation or cover seams in least visible locations.

D. Concealed Ducts: Adhere flexible insulation to ductwork with adhesive applied in 6 inch wide strips on 16 inch centers. Provide 16 gage annealed tie wire tied, spiral wound or half hitched at 16 inch centers for securing duct insulation until adhesive
sets. Butt insulation and seal joints and breaks [in ducts conveying air at less than room temperature] with 2 inch of foil adhered over joint.

E. Exposed Ducts: Adhere rigid insulation to ductwork with weld pins at 12 inches on center. Butt insulation and seal joints, breaks and pins with 2 inch wide adhesive backed foil tape.

F. Cover exposed insulation with 8 oz. canvas jacket.

G. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

END OF SECTION
SECTION 230719 - HVAC PIPING & EQUIPMENT INSULATION

PART 1 GENERAL

1.1 WORK INCLUDED

A. Insulation of Condensate Drain Piping

B. Insulation of Chilled and Heating Water Piping

1.2 RELATED WORK

A. Section 230500 – Common Work Results For HVAC

B. Section 232113 - HVAC Piping Systems

1.3 QUALITY ASSURANCE

A. All insulation materials required for piping, and mechanical equipment, etc. shall be furnished and installed under this contract. The execution of the work shall be by approved insulation contractor in strict accordance with the best practice of the trade and the intent of this Specification.

B. It is mandatory that all insulation be applied in a neat and workmanlike manner. Contractor shall be required to remove and replace all insulation not applied in strict accordance with manufacturer’s specifications or not presenting a neat finished appearance.

C. All insulation on indoor work shall have composite (insulation, jacket or facing, and adhesive used to adhere jacket or facing to the insulation) fire and smoke hazard Ratings, as tested by procedure ASTM E-84, NFPA 255 and UL 73 not exceeding Flame Spread of 25, Fuel Contributed of 50 and Smoke Developed of 50. Accessories, such as adhesives, mastics, cements, tapes and cloths for fittings shall have component ratings as listed above.

D. Insulation shall be continuous through wall, floor and ceiling openings and sleeves.

E. Specified mastics, adhesives and coatings shall be applied in strict accordance with manufacturer’s instructions, including recommended coverages.

1.4 SUBMITTALS

A. Submit materials and installation instructions in accordance with Section 230500 – Common Work Results For HVAC
PART 2  PRODUCTS

2.1  ACCEPTABLE MANUFACTURERS

A.  Products manufactured by Owens-Corning, Knauf, Johns Manville, Certain-Teed, Govain, Benjamin Foster are acceptable provided they meet or exceed these specifications.

2.2  PIPING

A.  Piping:

1.  Insulation thickness - Fiberglass pipe covering.

<table>
<thead>
<tr>
<th>PIPING TYPE</th>
<th>PIPE SIZE</th>
<th>INSULATION SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Water Supply &amp; Return</td>
<td>all sizes</td>
<td>1-1/2&quot;</td>
</tr>
<tr>
<td>Chilled Water Supply &amp; Return</td>
<td>all sizes</td>
<td>1&quot;</td>
</tr>
<tr>
<td>Condensate</td>
<td>all sizes</td>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

2.  All fiberglass pipe insulation shall be nominal 5 pcf density.

3.  Insulation jacket shall be factory applied white All Service Jacket (ASJ), with factory supplied self-sealing laps.

4.  Condensate piping may be insulated with 1/2" thick expanded rubber insulation at the contractor’s option.

5.  Fittings, Valves and Flanges:

a.  Where manufactured, factory premolded fittings (of the same material and thickness as the pipe insulation) shall be used for all fittings, flanges and valves.

b.  Where premolded insulation fittings are not manufactured, all fittings, flanges and valves shall be insulated with mitered segments of nominal 5 lb. density fiberglass pipe covering. Hot Service Finish: embed a 20 x 20 weave white glass reinforcing cloth between two 1/16 inch coats of Benjamin Foster 30-36. The glass cloth and second coat shall overlap adjacent covering by at least two inches. Cold Service Finish: same as above except use Benjamin Foster 30-35.
c. Insulation for removable flanges of pipe strainers shall be fabricated with built-up sections of Fiberglass pipe covering, so arranged as to facilitate servicing of the strainer. Applications for cold services shall be complete with vapor seals.

6. Insulation on pipes shall be protected by saddles from hangers, guides, and rollers.

PART 3 EXECUTION

3.1 PREPARATION

A. Do not install covering before piping and equipment has been tested and approved.

B. Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application.

3.2 INSTALLATION

A. Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, fully sealed.

B. Insulate fittings and valves. Do not insulate unions, flanges, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material troweled on bevel.

C. Finish insulation neatly at hangers, supports and other protrusions.

D. Locate insulation cover seams in least visible locations.

E. Cold Piping: Cover fittings and valves with equivalent thickness of insulation material. Cover with open mesh glass cloth sealed with vapor barrier sealant. Seal lap joints with 100% coverage of vapor barrier sealant and adhesive. Seal butt joints with 4 inches wide strips of vapor barrier sealed with vapor barrier adhesive. For exposed fittings and valves, apply, hydraulic setting cement paste over insulation material before applying canvas jacket.

F. Hot Piping: Cover fittings and valves with equivalent thickness of insulation material. For exposed fittings and valves apply hydraulic setting cement paste over insulating material before applying canvas jacket.

G. Equipment: Apply insulation with edges tightly butted, joints staggered and secured in place by steel bands. Where necessary weld on suitable anchors. Provide sufficient clearance around openings for normal operation of equipment. Finish hot
surface insulation with 1 inch galvanized hexagonal mesh and coat with hydraulic setting insulation cement. Finish cold surface insulation joints with 4 inches wide strips of vapor barrier sealed with vapor barrier adhesive finished insulation with heavy coat of vapor barrier mastic applied over whole body. Finish with a final coat of cement containing 25% by weight of Portland Cement. Recover and provide an extra coat of lagging adhesive.

H. Cover exposed insulation with 8 oz. canvas jacket.

I. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

END OF SECTION
SECTION 230900 – INSTRUMENTATION & CONTROL FOR HVAC

PART 1 GENERAL

1 SUMMARY

A This Section includes control equipment for HVAC systems and components, including control components for fans and valves not supplied with factory-wired controls and other equipment specified in the controls sequence.

B Drawings and general provisions of contract, including general and supplementary conditions and Division 1 apply to work specified in this section.

2 SUBMITTALS

A Product Data: For each control device indicated.

B Shop Drawings:

  1 Schematic flow diagrams.
  2 Power, signal, and control wiring diagrams.
  3 Details of control panel faces.
  4 Valve schedule.
  5 DDC System Hardware: Wiring diagrams, schematic floor plans, and schematic control diagrams.
  6 Control System Software: Schematic diagrams, written descriptions, and points list.
  7 Graphic Displays: Graphic displays of each page shall be submitted for approval.

C Software and firmware operational documentation.

D Field quality-control test reports.

E Operation and maintenance data.

3 QUALITY ASSURANCE

A All controllers and devices shall meet the requirements of ASHRAE BACnet Standard 135 for communication protocol at all levels.

B Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an OSHA Nationally Recognized Testing Laboratory, and marked for intended use.
PART 2 PRODUCTS

1 MANUFACTURERS

A In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2 CONTROL SYSTEM

A Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

B Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multi-user, multitasking environment on token-passing network and programmed to control mechanical systems. An existing operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics. Provide new graphics specifically for this project.

3 DDC EQUIPMENT

A Laptop Computer: Provide a laptop computer to be used as a direct connect field service tool with a minimum configuration as follows:

1 Motherboard: With 3 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
2 Processor: Intel Core i3-350M 2.26Gh.
3 Random-Access Memory: 4 GB.
5 Display: 14 inches, LCD color.
6 Hard-Disk Drive: 160 GB.
7 CD/DVD-ROM Read/Write Drive: 8 x CD/DVD-Burner.
8 Power: 6-cell Lithium Ion battery up to 4 hours and AC Adaptor.
9  Operating System: Microsoft Windows XP, Vista, or 7.

B  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.

2  Stand-alone mode control functions operate regardless of network status. Functions include the following:

   a  Global communications using ASHRAE BACnet protocol.
   b  Discrete/digital, analog, and pulse I/O using standard BACnet objects.
   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.

C  Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1  Units monitor or control each I/O point, process information, 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 using ASHRAE BACnet protocol.
   b  Discrete/digital, analog, and pulse I/O using standard BACnet objects.
   c  Monitoring, controlling, or addressing data points.

3  Local operator interface provides for download from or upload to operator workstation.

D  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.


7. Universal I/Os: Provide software selectable binary or analog outputs.

E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection with hi/lo disconnects; 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.

F. 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.

3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

4. ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
4. Room Sensor Cover Construction: Manufacturer's standard locking
covers.

a. Set-Point Adjustment: Concealed.
b. Set-Point Indication: Concealed.
c. Thermometer: Concealed.
d. Override Button: Exposed.
e. Communication: LAN BACnet port.

5. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

C. RTDs and Transmitters:

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
4. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
5. Room Sensor Cover Construction: Manufacturer's standard locking covers.

a. Set-Point Adjustment: Concealed.
b. Set-Point Indication: Concealed.
c. Thermometer: Concealed.
d. Override Button: Exposed.
e. Communication: LAN BACnet port.


D. Pressure Transmitters/Transducers:

1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Duct Static-Pressure Range: 0- to 5-inch wg.

2. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.

3. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas or liquid service; range suitable for system; linear output 4 to 20 mA.

E Flow Meter:
1. Accuracy: Plus or minus 1 percent at calibration point with repeatability of 0.2% and a turndown ratio of 40:1.
2. Wire: Twisted, shielded-pair cable.

F Airflow Sensors/Transmitters:
1. Transmitters to have 24VAC/DC input power and 4-20mA/0-5V output.
2. In Duct Sensors: Multi-probe traverse equal to Air Monitor Volu-probe/VSS & Veltron DPT 2500 Transmitter or Ebtron GTA116-PD.

G Refrigerant Sensor:
1. Refrigerant monitor shall be specifically for R410A to match the actual refrigerant selected.
2. Provide automatic re-zero calibration.
3. Monitor to be an IR type capable of sensing refrigerant concentrations down to 10 parts per million.
4. Unit to operate on 24V power supply from a dedicated controller UL-864 UUKL listed for life safety.

5 STATUS SENSORS
A 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.

B Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

C Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

D 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.

E Emergency Refrigeration Machinery Room Switches: Break glass type
switches per IMC and IFC requirements.

6 ACTUATORS

A Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1 Manufacturers:

a Belimo Aircontrols (USA), Inc.

2 Valves: Size for torque required for valve close off at maximum pump differential pressure.

3 Coupling: V-bolt and V-shaped, toothed cradle.

4 Overload Protection: Electronic overload or digital rotation-sensing circuitry.

5 Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.

6 Power Requirements (Two-Position Spring Return): 24-V ac.

7 Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

8 Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

9 Temperature Rating: Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C).

7 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 Hydronic system globe valves shall have the following characteristics:

1 NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure. Characterized ball valve is acceptable.

2 Internal Construction: Replaceable plugs and stainless-steel or brass seats.

a Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
b  Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

3  Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate or the following:
   a  Two Position: Line size.
   b  Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   c  Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

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.

C. 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.

2. Disc Type: Aluminum Bronze.

8  CONTROL DAMPERS

A  Dampers: AMCA rated, opposed-blade design; galvanized or aluminum construction equal of Ruskin CD35.

9  CONTROL CABLE

A  Wide Area Network (WAN)

1  Coordinate WAN connection location and type with TUSD. Coordinate proper addressing of network and objects numbers with TUSD. Provide all cabling from main controller to TUSD WAN connection.
2  Provide BACnet IP Router for connection to the WAN.
3  Provide surge protection circuits at each end of communication links between equipment at all building penetrations.

B  Local Area Network (LAN)
1. The LAN shall support BACnet/Ethernet or BACnet/IP and shall share a common network number as defined in BACnet. Network numbers shall be defined and coordinated with TUSD.

2. The LAN shall be continuous, hard-wired media. Power-line communication shall not be acceptable for communications.

3. The minimum data transmission speed from the Building Control Units shall be 10 Mbps or greater. The minimum speed from the Local Control Units shall be 56,600 baud.

4. All LAN cabling shall be in EMT conduit. Cabling above lay-in ceilings can be plenum rated cable secured to ductwork or building structure.

C Electrical Wiring

1. All wire, wiring and conduit required for the operation of the controls shall be the responsibility of this contractor and shall be installed as described and in accordance with the requirements of acceptable local governing building codes and those defined by the National Electrical Code (NEC).

2. This contractor shall be responsible for supplying complete and approved wiring diagrams and installation supervision of the wiring of the control system and shall perform all necessary set-up and calibration labor.

3. Starters, furnished in other sections of these specifications, shall be installed under the electrical specifications, but all low voltage wiring from auxiliary contacts or relays shall be under this section of the specifications.

4. All wiring, including Class 2 signal wiring, shall be installed as a Class 1 electrical system as defined by the NEC.

5. All conduit shall be 1/2 inch size minimum. EMT conduit may be used for mechanical rooms and finished spaces. EMT installation shall meet local governing building codes. Rigid conduit will be used for underground or exterior building circuits or where specifically noted.

6. All wiring in exposed areas of mechanical rooms and finished spaces shall be run in EMT conduit. All Class 1 power wiring shall be run in conduit in exposed and concealed areas. EMCS bus wiring must not be run in the same conduit line voltage wiring (30 VAC or above) or wiring that switches power to highly inductive loads (contactors, coils, motors, generators, etc.). Electronic control circuit wiring shall not be run in the same conduit containing other electrical wiring.

7. Low voltage wiring above lay-in ceilings may be exposed cabling secured to building structure or ductwork.

PART 3 EXECUTION

1 INSTALLATION
A Verify location of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.

1 Install averaging elements in ducts and plenums in crossing or zigzag pattern.

B Install labels and nameplates to identify control components.

C Install hydronic instrument wells, valves, and other accessories according to Division 23.

2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A Install raceways, boxes, cabinets, wire and cable according to Electrical Specifications.

B Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

C Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3 FIELD QUALITY CONTROL

A Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B Perform the following field tests and inspections and prepare test reports:

1 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2 Test and adjust controls and safeties.

3 Test calibration of 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 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 air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
9  Check DDC system as follows:
   a  Verify that DDC controller power supply is from emergency power supply, if applicable.
   b  Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c  Verify that spare I/O capacity has been provided.
   d  Verify that DDC controllers are protected from power supply surges.

D  Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

4  DEMONSTRATION

A  Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls.

B  Coordinate content of training with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Architect.

C  Develop a learning objective and teaching outline. Include a description of specific skills and knowledge that participant is expected to master. Include instruction for the following:
1 Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.

2 Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.

3 Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.

4 Operations: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.

5 Adjustments: Include alignments and checking, noise, vibration, economy, and efficiency adjustments.

6 Troubleshooting: Include diagnostic instructions and test and inspection procedures.

7 Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.

8 Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

D Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1 Schedule training with Owner with at least seven days' advance notice.

E Evaluation: At conclusion of training, assess and document each participant's mastery by use of a demonstration performance-based test.

F Record demonstration and training on videotapes. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

5 COMMISSIONING

A. Provide all commissioning assistance, documentation, and repairs as described in Section 230800.
END OF SECTION
SECTION 230901 – VARIABLE FREQUENCY DRIVES

PART 1    GENERAL

1.1   WORK INCLUDED

A. Variable Frequency Drives with VFD By-Pass

1.2   RELATED WORK

A. Section 230500 – Common Work Results for HVAC

B. Section 233423 – HVAC Power Ventilators

C. Section 237413 – Modular Central Station Air Handling Units

1.3   REFERENCES

A. VFD and options shall be UL Listed and comply with the applicable requirements of the latest standards of the National Electric Code (NEC). VFD's and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable.


C. Underwriters Laboratories: UL508C

D. National Electrical Manufacturer's Association (NEMA) ICS 7.0, AC Adjustable Speed Drives

E. IEC 16800 Parts 1 and 2

1.4   SUBMITTALS

A. Submit product data in accordance with Section 230500.

B. Product data to include wiring diagrams, including field wiring connections, dimensions, installation instructions, programming instructions, service and start-up procedures, display features, protection devices and operating and maintenance instructions.
1.5 WARRANTY

A. Contractor shall warranty materials and installation for a period of two (2) years from final completion.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Units manufactured by ABB, ACH Series designed specifically for HVAC applications, provided they meet or exceed these specifications.

B. All variable frequency drives required for this project shall be provided by a single manufacturer, delivered to the site. The VFDs for the air handlers can be field or factory installed.

2.2 GENERAL

A. Variable frequency drive (VFD) controllers shall be provided to control the all fans and pumps where shown on the plans. The manufacturer of the VFD controller shall have a minimum of 20 years experience in the design, construction and application of said devices.

B. The VFD controller shall be a fully digital PWM using very large scale integration techniques (VSLI) as well as surface-mount technology for increased reliability. The VFD shall be listed ISO9001 and the package as specified herein shall be enclosed in a UL Listed Type 1, 12 (indoor enclosures) or 3R (outdoor enclosure) as applicable/specifed. Environmental operating conditions: -15 to 40 deg. C to (5 to 104 deg. F) ambient temperature continuous with no current de-rate from 40 deg. C (104 deg. F) to 50 deg. C (122 deg.F) ambient temperature range, VFD current de-rate will not be greater than 10% and not exceed a rate of 1% current de-rate per 1deg. C or VFD must be oversized. VFD's that can operate at 40deg. C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. Enclosure shall be UL listed as a plenum rated VFD. VFD's without these ratings are not acceptable. The VFD system consisting of VFD and integrated bypass, when specified, shall be UL listed for 100,000 AIC without the need for input fuses.

C. All programmable settings shall be held in non-volatile memory and shall not be affected by power outages, brownouts, power dips, etc. The VFD shall have initial programmable settings intact from the factory without the need of battery backup, etc. The VFD shall not need to be programmed at the job site prior to being able to

VARIABLE FREQUENCY DRIVES
run a motor, but shall be ready to run a motor as soon as power connections are made. Programming at the job site to accommodate specific local application requirements, such as frequency avoidance and preset speeds shall be available at no cost to the owner.

1. There shall be a built-in time clock in the VFD keypad. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays, four (4) separate, independent timer functions that have both weekday and weekend settings.

2. The VFD's shall utilize pre-programmed HVAC application macro's specifically designed to facilitate start-up.

2.3 BASIC FEATURES

A. Operators controls shall be mounted on the door of the cabinet and consist of a membrane command center Keypad which allows manual stop/start and speed control, local/remote indication and manual/or automatic speed control selection. In addition, the command center will serve as a means to configure controller parameters such as min. speed, max. speed, acceleration and deceleration times, volts/Hz ration, torque boost, etc. Potentiometer will not be allowed for these settings.

B. The controller will be able to follow an external speed signal and respond to remote start/stop contacts wired to the terminal strip while in the automatic/remote mode.

C. The main input circuit breaker disconnect shall provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be mounted inside the controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.

D. The controller shall contain an electronic overload circuit designed to protect one A-C motor, operated on the Variable Frequency Drive output form extended overload operation on an inverse time basis.

E. The VFD shall automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal. Automatic restarts will be attempted three times after a power outage, drive fault or external fault, if the drive is in automatic mode. The circuit shall allow the user to select 0, 1, 2 or 3 restart attempts as well as select the dwell time between attempts. The reset time between fault occurrences shall also be selectable. All settings shall be via the membrane command center. The VFD shall have the capability to ride through power dips up to 500 msec without a
controller trip depending on load and operating condition. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.

F. An LED display will be mounted on the door of the cabinet and will digitally indicate:

1. Frequency output
2. Voltage output
3. Current output
4. First fault indication

G. The Variable Frequency Drive shall be capable of starting into a rotating load without the need of a time delay upon a start command.

H. There shall be three critical frequency avoidance bands which can be programmed in the field via the membrane command center to enable the controller to avoid certain frequencies which the fan may resonate at due to reduced speed operation. Each critical frequency avoidance band shall have a bandwidth adjustable via keypad entry of up to 10 Hz. There shall be three programmable preset speeds which will force the VFD to a preset speed upon a user contact closure. This feature shall be set digitally by entering via the door mounted membrane command center.

I. Isolated electrical follower shall enable the VFD to follow a 0-20ma, 4-20ma, or 0-10 volt D-C grounded or ungrounded signal from a process device.

1. Two (2) programmable analog inputs shall accept current or voltage signals.
2. Two (2) programmable analog outputs (0-20ma or 4-20ma)
3. Six (6) programmable digital inputs allowing multiple safeties, run permissive circuits for damper and valve control, etc.
4. The VFD shall include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezeastat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
5. Three (3) programmable digital Form-C relay outputs standard, expandable to (6). The relays shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC or 250 VAC. Maximum voltage 30 VDC and 250 VAC with maximum continuous current rating 2 amps RMS. Outputs shall be true form C type contacts; open collector outputs are not acceptable.

J. Line inductors in the form of line reactors or isolation transformers shall be provided to minimize line surges, line notching and voltage distortions from causing nuisance trips.

1. The VFD shall have integral 5% impedance line reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% impedance AC line reactors. VFD's with only one 5% DC reactor shall add AC line reactors.

2. The VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.

3. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level.

K. The VFD shall include instantaneous Electronic Trip for motor current exceeds 110% for longer than one minute of controller maximum sine wave current rating, output phase-to-phase short circuit condition, total ground fault under any operating condition, high input line voltage, low input line voltage, loss of input phase and external fault.) This protective circuit shall permit, by means of the terminal strip, wiring of remote N.C. safety contact such as high static, firestat, etc. to shut down the drive.) All live power equipment shall be converted by protective shields to insure the safety of operating personnel.

L. The VFD controller shall be functionally tested under motor load and must pass a 20 minute heat run under motor load. In addition, every VFD shall be temperature cycled under constantly varying environmental and line conditions while the unit is cycling a motor under computer control. This test shall be running simultaneously while the temperature is cycled between 7 degrees C and 45 degrees C. Electronic printed circuit board assemblies shall be tested for continuity of filed and correct components before they are functionally tested. The major complex circuits shall be temperature cycled for a nominal 24 hour period between 15 degrees C and 55 degrees C.
M. The VFD Controller manufacturer shall have the ability to test both the controller and the motor at manufacturer staffed service centers.

N. Provide a manual by-pass VFD for all AHUs, pumps, and cooling tower fans. Bypass shall include the following and all features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label:

1. VFDs intended for wall or unit mounting with all disconnects, relays, cabling/bussing, etc. Internal to one UL listed panel. External indication for which drive is operational.

2. VFD units to possess two physical variable frequency drives, each drive fully capable of driving the selected motor HP and configuration.

3. Unit to have one point of connection for supply power (line side) and output power (load side).

4. Unit to provide complete redundancy of primary variable frequency drive.

5. Upon manual switchover of either VFD, drive speed, drive enable, safeties, start/stop circuits, and EMCS communications shall electrically be disconnected from the failed drive so drive can be removed without causing control circuit problems.

6. Unit to be configured to allow lock-out of either VFD for servicing or replacement. Disconnect switches, barriers, wiring, etc, will be provided in unit to allow removal and service of a VFD. Provide a separate isolation fusing at each VFD and a master disconnect switch for the entire unit, interlocking relays, etc.

7. The drive / bypass shall provide single-phase motor protection and under-voltage protection of bypass, contactor coils, etc. shall be in both the VFD and bypass modes.

8. The following operators shall be provided:
   a. Bypass Hand-Off-Auto
   b. Drive mode selector
   c. Bypass mode selector
   d. Bypass fault reset

9. The following indicating lights (LED type/pilot light) shall be provided. A test mode or push to test feature shall be provided.
a. Power-on (Ready)
b. Run enable (safeties) open
c. Drive mode select damper opening
d. Bypass mode selected
e. Drive running
f. Bypass running
g. Drive fault
h. Bypass fault
i. Bypass H-O-A mode
j. Automatic transfer to bypass selected
k. Safety open
l. Damper open
m. Damper end-switch made

10. The following relay (form C) outputs from the bypass shall be provided:

a. System started
b. System running
c. Bypass override enabled
d. Drive fault
e. Bypass fault motor overload or underload (broken belt)
f. Bypass H-O-A position

11. Customer Interlock Terminal Strip for connection of freeze, fire, smoke contacts, and external start command. The remote start/stop contact shall operate in VFD and bypass modes.

12. Class 20 or 30 (selectable) electronic motor overload protection shall be included.

13. The bypass and VFD shall be monitored and controlled by a serial communication port meeting the ASHRAE BACnet Standard communication protocol.

PART 3 EXECUTION

3.1 INSTALLATION

A. Certified factory start-up shall be provided for each drive by a factory authorized service center along with physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements. Training shall be 4 hours, provided on site and shall include system concepts and basic troubleshooting. A reasonable supply of spare parts must be kept available for the VFD to meet
ordinary repair requirements and must be available within 24 hours of notification through a local service center.

B. Wiring between fans/pumps and Variable Frequency Drive controllers shall be as outlined in the installation manual and as per Division 26 unless specifically scheduled and specified to be factory wired and installed.

END OF SECTION
SECTION 232113 - HVAC PIPING SYSTEMS

PART 1  GENERAL

1.1  WORK INCLUDED

A. Heating Hot Water Piping Systems
B. Chilled Water Piping Systems

1.2  RELATED WORK

A. Section 230500 – Common Work Results For HVAC
B. Section 230519 - Piping Specialties
C. Section 230529 - Supports, Anchors and Sleeves For HVAC
D. Section 230523 - Valves For HVAC
E. Section 230719 - HVAC Piping and Equipment Insulation

1.3  SUBMITTALS

A. Submit product data on materials to be used in accordance with Section 230500 – Common Work Results For HVAC

1.4  QUALITY ASSURANCE

A. Welding materials and labor to conform to ASME Code and applicable state Labor Regulations.
B. Use welders fully qualified and licensed by state authorities.
C. All piping shall be manufactured in the United States.

1.5  REFERENCES

A. ANSI/ASTM A53 - Pipe, steel, Black and Hot-Dipped Zinc- Coated, Welded and Seamless.
B. ANSI/ASME B16.3 - Malleable - iron, Black or Galvanized, Threaded Fittings
C. FS WW-P-521 - Pipe Fittings, Flange Fittings, and Flanges: Steel and Malleable Iron (Threaded and Butt Welding), Class 150.

1.6 PIPING, GENERAL

A. The accompanying drawings are intended for the contractor's guidance, and he shall verify their accuracy and immediately notify the Architect of any discrepancies so that such discrepancies may be resolved prior to actual fabrication or installation of work. Minor changes in position of piping as necessary to meet job conditions shall be anticipated by the contractor and shall not be made the basis for change order. Changes affecting accessibility to or clearance about equipment or accessories shall be promptly communicated to the Architect.

B. Sizes and arrangement of piping shall be as shown on the drawings. In case of inconsistency of details for final connections, resulting in conflict, such conflict shall be resolved by the Architect.

C. Attention is called to the inclusion of the "piping diagrams" in the working drawings. These piping diagrams are not for the purpose of giving physical dimensions or locations but rather to make clear the interconnections, by the piping, of the various units of the process. If an item is shown on either the piping diagram or the piping detail drawings, but not on both, it will be assumed that the Contractor has included such item in his estimate of the cost of the work and that he shall install same.

PART 2 PRODUCTS

2.1 PIPE AND TUBE

A. Chilled and Heating Water Piping, Schedule 40, ANSI/ASTM A-53 seamless black steel pipe plain end or grooved end.

2.2 PIPE AND TUBE JOINTS AND FITTINGS

A. Threaded Steel Pipe Fittings: ANSI/ASME B16.3 black or galvanized malleable iron threaded fittings.

B. Grooved Steel Pipe Fittings: ASTM A47 malleable iron or ASTM A536 black or galvanized, ductile iron. UL listed and FM approved.

C. Copper Drainage Pipe Fittings:

1. ANSI B16.23, cast copper alloy solder joint drainage fittings, type DWV.
2. ANSI B16.29, wrought copper and wrought copper alloy solder joint drainage fittings.

2.3 UNIONS AND COUPLINGS

A. Pipe Size 2 Inches and Under: 150 psi malleable iron for threaded ferrous piping.

B. Pipe Size 2-1/2 Inches and Over: 150 psi forged steel flanges for ferrous piping.

C. Grooved End Pipe: Malleable iron or ductile iron split couplings with ASTM D-2000 sealing gasket, bolts and nuts; galvanized couplings for galvanized pipe.

2.4 VALVES

A. Valves shall be in accordance with Section 230523.

PART 3 EXECUTION

3.1 INSTALLATION

A. Grade piping to facilitate drainage.

B. Install piping with careful regard to expansion.

C. All piping shall be run straight and parallel with adjacent walls and shall present a uniform and neat appearance.

D. Make connections to equipment with unions or flanges.

E. On closed systems, equip all low points with 3/4 inch drain valves and hose ends. Provide air vents at high points.

F. Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting.

G. Group piping whenever practical at common elevations.

H. Provide clearance for installation of insulation and for access to valves, air vents, drains and unions.

3.2 IDENTIFICATION
A. Provide Seaton, Brady or equivalent pipe markers per ANSI Standards for pipe identification for all piping.

B. Each marker shall indicate direction of flow with an arrow pointing away from the marker. When flow can be in each direction, the marker shall have double-ended arrows.

C. Locate pipe markers so that the view is unobstructed.

D. Apply pipe markers at intervals not exceeding 10' in mechanical rooms and 20' at all other locations. Also, locate pipe markers at every point of pipe entry or exit of equipment and rooms.

E. All interior markers shall be plastic snap-on markers. Markers applied with adhesive will not be permitted. Snap-on markers to be equivalent to Seaton Setmark pipe markers.

3.3 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, inside and outside, before assembly.

C. Remove rust or foreign material from pipe and fitting materials.

D. Clean the ends of copper pipe and the inside of soldered fittings with emery cloth, metallic wool, or other suitable means prior to joining.

3.4 STEEL PIPE CONNECTIONS

A. Use galvanized fittings, flanges and couplings for galvanized pipe.

B. Screw joint steel piping up to and including 2 inches. Weld piping 2-1/2 inch and larger, including branch connections.

C. Die cut screwed joints with full cut standard taper pipe threads using linseed oil. Make joints using non-toxic joint compounds applied to male threads only.

D. Use main sized saddle branch connections for directly connecting branch lines to mains in steel piping. Do not project branch pipes inside the main pipe.

E. Joints for Threaded End Pipe: Coated with pipe lubricant compound.
F. Flanged Connections: Tighten nuts uniformly. Bolts shall not protrude more than 1/4" through the tightened nut.

3.5 TESTING

A. Test piping systems prior to the application of insulation.

B. For piping installed in concealed spaces or buried, test piping before system is concealed or backfilled.

C. Test water piping to a hydrostatic pressure of 1-1/2 times normal operating pressure, 100 psig minimum, for a continuous period of not less than eight hours. During this time carefully inspect the system for leaks. If necessary repair leaks in a manner acceptable to the architect and test again until no leakage is detected.

D. After testing, and whenever conditions permit, operate systems at normal operating pressure and temperature for not less than five consecutive days. The piping systems must remain free from leaks during this period.

E. Test using higher pressures if required by authorities having jurisdiction.

3.6 WATER TREATMENT

A. After piping has been tested leak free, flush the system clean with a liquid alkaliner cleaner formulated with soaps, synthetic detergents and dispersants. Cleaner shall be equal to Western Water Technologies #CL-83. Apply as per manufacturer's instructions.

B. Provide a nonchromate and organic corrosion inhibitor equal to Western Water Technologies #CS-1000 boron nitrite to system before start-up of system. Apply with by-pass feeder as per manufacturer's instructions.

END OF SECTION
SECTION 232300 - REFRIGERANT PIPING

PART 1  GENERAL

1.1  WORK INCLUDED

A.  Refrigerant Piping Systems

1.2  RELATED WORK

A.  Section 230500 – Common Work Results for HVAC

B.  Section 238126 – Split System Air Conditioners

1.3  REFERENCES

A.  ANSI/ASTM B280 - Copper Air Conditioning and Refrigeration Tube (ACR).

PART 2  PRODUCTS

2.1  REFRIGERANT PIPING

A.  Type ACR Copper tubing, hard temper with wrought copper fittings with long radius elbow.

2.2  JOINTS

A.  Brazed, phos-copper alloy or bronzed, silver alloy.

PART 3  EXECUTION

3.1  INSTALLATION

A.  Grade piping as necessary to facilitate oil return when required.

B.  Joints shall be made up in the presence of dry nitrogen only and shall be tested before any coverings are applied. High side shall be tested at 400 psig and the low side at 250 psig.

C.  All joints shall be carefully tested and if a leak is found, the joint shall be remade as described above. If no leaks are found, system shall be evacuated to a deep vacuum. Charge system as per manufacturer’s recommendation.
D. Provide 1" thick expanded rubber insulation to suction return line and paint exterior insulation with two coats of weather-resistant pigmented plasticized vinyl lacquer. Apply per manufacturer's specifications.

3.2 TESTING

A. Test piping systems prior to the application of insulation.

B. For piping installed in concealed spaces or buried, test piping before system is concealed or backfilled.

C. After testing, and whenever conditions permit, operate systems at normal operating pressure and temperature for not less than five consecutive days. The piping systems must remain free from leaks during this period.

END OF SECTION
SECTION 233100 - HVAC DUCTS

PART 1  GENERAL

1.1  WORK INCLUDED

A.  Ductwork
B.  Fasteners
C.  Sealants
D.  Duct Cleaning
E.  Testing

1.2  RELATED WORK

A.  Section 230500 – Common Work Results For HVAC
B.  Section 230529 - Supports, Anchors and Sleeves For HVAC
C.  Section 230593 - Testing, Adjusting and Balancing
D.  Section 230713 - Ductwork Insulation
E.  Section 233423 - Power Ventilators
F.  Section 233300 - Duct Liners
G.  Section 233300 - Duct Accessories
H.  Section 233713 - Diffusers, Registers & Grilles
I.  Section 237413 – Modular Outdoor Central Station Air Handling Units

1.3  REFERENCE STANDARDS

A.  Fabricate in accordance with the most recent edition of SMACNA HVAC Duct Construction Standards.

1.4 DEFINITIONS

A. Duct Sizes: Dimensions shown on the Drawings are sheet metal sizes.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products manufactured by the following manufacturers meeting these specifications are acceptable.

B. Flexible ducts manufactured by Thermaflex, Wire Mold, Certain Tweed and ATCO are acceptable.

C. Round and oval ductwork manufactured by United Sheet Metal, Semco, General Metals, Spiro-Fab and Metal Manufacturing are acceptable.

2.2 MATERIALS

A. Galvanized Ductwork: Galvanized steel lock forming quality having zinc coating of 1.25 ounces per square foot for each side per ASTM A525 G90. All ductwork to be galvanized unless otherwise noted.

B. Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

C. Sealant: Water resistant, fire resistive, compatible with mating materials.

D. Flexible Ducts: UL 181 Class 1 airduct consisting of inner vapor barrier supported by a helically wound steel wire; wrapped with 1-1/2" thick flexible fibrous glass insulation, enclosed by a reinforced foil outer jacket. Ductwork shall be a factory fabricated assembly with hanger tab support system equal to CertainTeed Certaflex 25.

2.3 FABRICATION

A. The contractor shall visit the premises and thoroughly familiarize himself with all the details of the work and working conditions and to verify all dimensions in the field.
prior to fabricating ductwork. The contractor shall advise the Architect of any discrepancy prior to fabrication.

B. Size round ducts installed in place of rectangular ducts from ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission.

C. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

D. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on center line. Where not possible and where rectangular elbows used, provide single thickness type turning vanes.

E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Maximum divergence upstream of equipment to be 30 degrees and 45 degrees convergence downstream.

F. Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate, or sag. Seal all duct joints and connections with "hard cast" tape sealant or equal as ducts are being assembled.

G. Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two ducts maintaining original duct area.

2.4 DUCT GAUGES AND REINFORCEMENT

A. Provide minimum duct wall thickness and reinforcement as required by the latest edition of the SMACNA HVAC Duct Construction Standards.

PART 3 EXECUTION

3.1 INSTALLATION

A. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
B. Clean duct system with forced air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.

C. Seal all transverse joints with Hard Cast or equivalent.

D. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

E. At each point where ducts pass through partitions, seal joints around duct with non-combustible material. Provide sheet metal closure around opening when exposed.

F. Paint all exposed ductwork as directed by architect.

END OF SECTION
SECTION 233300 - DUCT ACCESSORIES

PART 1     GENERAL

1.1     WORK INCLUDED
  A. Access Doors
  B. Balancing Dampers
  C. Backdraft Dampers
  D. Flexible Connections
  E. Turning Vanes

1.2     RELATED WORK
  A. Section 230500 – Common Work Results For HVAC
  B. Section 23 0593 - Testing, Adjusting and Balancing
  C. Section 233100 - HVAC Ducts
  D. Section 233713 - Diffusers, Registers & Grilles

1.3     QUALITY ASSURANCE
  A. Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems as applicable.
  B. Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

1.4     SUBMITTALS
  A. Submit product data in accordance with Section 230500 – Common Work Results For HVAC

PART 2     PRODUCTS

2.1     ACCEPTABLE MANUFACTURERS
A. Products manufactured by Air Balance, Greenheck, DuroDyne, Penn, Krueger, Safe Air, Dowco or Ruskin meeting these specifications are acceptable.

2.2 ACCESS DOORS

A. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For internally lined or insulated ductwork, install minimum one inch thick insulation with sheet metal cover.

B. Provide two hinges and two sash locks for sizes up to 18 inch square, two hinges and two compression latches with outside and inside handles for sizes up to 24 inch x 48 inch. Provide an additional hinge for larger sizes.

2.3 DAMPERS

A. Fabricate counter balanced backdraft dampers with blades a maximum 8 inch width having felt or flexible vinyl sealing edges, linked together in rattle-free manner and width adjustment device to permit setting for varying differential static pressure.

2.4 FLEXIBLE CONNECTION

A. Fabricate of neoprene coated flameproof fabric approximately 4 inch wide tightly crimped into metal edging strip and attach to ducting and equipment by screws or bolts at 6 inch intervals.

2.5 TURNING VANES

A. Fabricate turning vanes and rails of 24 gauge galvanized steel and assemble rattle free.

B. Turning vanes shall be single thickness prefabricated or assembled per manufacturer's instructions for optimum shape.

C. Secure to duct with sheet metal screws, rivets or weld. Final assembly shall be rattle free.

2.6 APPLICATION

A. Provide access doors for inspection and cleaning at filters, fans, and as indicated on the drawings. Review locations prior to fabrication.

B. Provide flexible connections immediately adjacent to equipment, in ducts associated with fans, equipment subject to forced vibration and as shown on the drawings.

DUCT ACCESSORIES
PART 3 EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturer’s printed instructions and SMACNA Standards.

B. For connections to fans, install 1/2 inch thick neoprene pad over fabric and hold in place with additional metal strips.

END OF SECTION
SECTION 233353 - DUCT LINERS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Duct Lining

1.02 RELATED WORK

A. Section 230500 – Common Work Results For HVAC

B. Section 233100 - HVAC Ducts

1.03 QUALITY ASSURANCE

A. International Mechanical Code and Local Codes

B. ASTM E-84 and NFPA 90A for Fire Hazard Classification

C. ASTM D 903 for Adhesive Bonds

1.04 REFERENCE STANDARDS

A. TIMA AHC-101

B. ASTM C-423-77 for Sound Absorption

C. ASTM C-177 for Thermal Conductance

D. SMACNA Duct Liner Application Standard

1.05 SHOP DRAWINGS

A. Submit product data and installation instructions in accordance with Section 230500 – Common Work Results For HVAC.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Products manufactured by Johns-Manville, Knauf, Owens-Corning or CertainTeed meeting these specifications are acceptable.
2.02 MATERIALS

A. All rectangular supply and return ductwork shall be provided with Type 1 flexible duct liner, 1" thick, 1-1/2 lbs. per cubic foot density "K" value at 75 degrees F mean temperature of 0.26 BTU/in/sq. ft./degrees F/hr., suitable for temperature range of 40 degrees F to 250 degrees F and maximum velocity of 4000 fpm.

B. Weld pins or approved equal mechanical fasteners capable of withstanding 50 lb. tensile load test.

C. Adhesives meeting FM, UL and NFPA requirements for fire and smoke ratings, maximum 25 flame spread and maximum 50 smoke developed. Adhesives shall conform to Adhesive and Sealant Council Standards for Adhesives for Duct Liner ASC-A-7001C-1972.

PART 3 EXECUTION

3.01 INSTALLATION

A. All duct designated to receive liner shall be completely covered with liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The black coated surface of the duct liner shall face the air stream. Provide 26 gauge galvanized steel "Z" strip at leading edge of duct liner.

B. Duct liner shall be adhered to sheet metal with mechanical fasteners and 100% coverage of adhesive. Transverse edges of liner to be coated with adhesive. Duct liner shall be cut to assure overlapped and compressed longitudinal corner joints.

C. For velocities up to 2,000 feet per minute, fasteners shall start within 3" of the upstream transverse edges of the Duct Liner and 3" from the longitudinal joints and shall be spaced at a maximum of 12' o.c. around the perimeter of the duct, except that they may be a maximum of 12" from corner break. Elsewhere they shall be a maximum of 18" o.c. except that they shall be placed no more than 6" from a longitudinal joint of the liner nor 12" from a corner break.

END OF SECTION
SECTION 233417 - UTILITY FANS

PART 1  GENERAL

1.1  WORK INCLUDED

A. Utility Fans

1.2  RELATED WORK

A. Section 230500 – Common Work Results for HVAC
B. Section 230593 – Testing, Adjusting & Balancing For HVAC
C. Section 230900 – Instrumentation & Control For HVAC
D. Section 233113 – Ductwork
E. Section 233300 – Air Duct Accessories

1.3  QUALITY ASSURANCE

A. AMCA rated for both sound and air flow performance
B. AMCA rating seals
C. Fan shall be factory tested in accordance with AMCA Standard 210.

1.4  SUBMITTALS

A. Submit product data including dimensional data, material specifications, capacity data, sound data and installation procedures in accordance with Section 230500.

PART 2  PRODUCTS

2.1  ACCEPTABLE MANUFACTURERS

A. Products manufactured by Greenheck, Cook, Penn, Jenn Fan, or ACME meeting these specifications are acceptable.

2.2  PERFORMANCE

A. Provide air flow capacity and all other performance requirements scheduled on the drawings.
2.3 CONSTRUCTION

A. Fan wheels shall be aluminum construction, spark resistant, backward inclined, non-overloading centrifugal type, statically and dynamically balanced. RPM and motor horsepower shall be as specified and shall not exceed the maximum listing in the manufacturer's catalog for the unit specified.

B. Housing shall be heavy gauge steel. Housing shall be field rotatable to any of the eight standard discharge positions.

C. Motor shall be permanently lubricated, heavy duty ball bearing type, of the voltage, phase and horsepower specified. Provide adjustable motor supports, variable drive sheave with companion sheave and anti-friction ball bearings.

D. Fan shall be belt driven.

E. Discharge duct from exhaust fans shall be in the upward direction with a 1/4" drain hole in the bottom of the fan housing. Provide weather cover for belt and motor section.

F. Fans connected to fume hoods shall have all wettedpard and outside scroll coated with black tung oil phenolic synthetic resin equal to Eisenheiss.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install fan as per drawing and in compliance with manufacturer's instructions. Carefully coordinate exact location with existing conditions.

B. Connect to ductwork as specified in Section 233113.

C. Balance in accordance with Section 230593.

END OF SECTION
SECTION 233423 - POWER VENTILATORS

PART 1  GENERAL

1.1  WORK INCLUDED
    A.  Curb Mounted Roof Exhaust Fans
    B.  Ceiling Exhaust Fans

1.2  RELATED WORK
    A.  Section 230500 – Common Work Results For HVAC
    B.  Section 233100 - HVAC Ducts
    C.  Section 230593 - Testing, Adjusting and Balancing

1.03  QUALITY ASSURANCE
    A.  AMCA rated for both sound and air flow performance
    B.  AMCA rating seals

1.04  SUBMITTALS
    A.  Submit product data including dimensional data, material specifications, capacity data, sound data and installation procedures in accordance with Section 230500.

PART 2  PRODUCTS

2.01  ACCEPTABLE MANUFACTURERS
    A.  Products manufactured by Greenheck, Cook, Penn, Jenn Fan, Twin City or ACME meeting these specifications are acceptable.

2.02  CURB MOUNTED ROOF EXHAUST FAN
    A.  Provide direct driven or belt driven centrifugal roof exhausters as scheduled. Performance shall meet or exceed that scheduled.
    B.  Ventilator housing shall be of heavy gauge spun aluminum construction or formed galvanized steel and shall be weatherproof, incorporating an integral weather shield.
C. Ventilators shall be furnished with birdscreen.

D. Fan wheels shall be backward inclined, non overloading centrifugal type, statically and dynamically balanced. RPM and motor horsepower shall be as specified and shall not exceed the maximum listing in the manufacturer's catalog for the unit specified.

E. Housing shall be provided with wiring channel and is to be of the direct discharge design.

F. Motor and fan assembly shall be on vibration isolating mounts.

G. Motors shall be permanently lubricated, sealed ball bearing type self-cooled with clean, cool, outside air and shall be located in a compartment separate from the exhaust air stream so that no lint, heat, grease, fumes, or dust in the exhaust air can come in contact with the motor.

2.3 CABINET EXHAUST FANS

A. Provide direct driven centrifugal fan. Performance shall meet or exceed that scheduled.

B. Fan wheels shall be forward curved type statically and dynamically balanced for vibration free operation. Motor shall have built in thermal overload protection and shall be mounted on vibration isolators. Fan scroll shall be galvanized steel of lock seam construction.

C. Housing shall be lined with acoustical fiberglass insulation. Construction shall be of corrosion resistant galvanized steel. Exhaust grille when required shall be aluminum with white baked enamel finish.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install exhaust fans with vibration isolation as indicated on drawings.

B. Install roof exhauster on roof curb fabricated or provided by fan manufacturer. Carefully coordinate exact curb dimensions.

C. Connect to ductwork as specified in Section 233100.

D. Balance in accordance with Section 230593.
END OF SECTION
SECTION 233600 - AIR TERMINAL UNITS

PART 1 GENERAL

1.1 WORK INCLUDED

A. Single duct terminal units.

1.2 RELATED WORK

A. Section 230500 – Common Work Results for HVAC
B. Section 230529 – Hangers & Supports for HVAC
C. Section 230593 – Testing, Adjusting & Balancing For HVAC
D. Section 230900 – Instrumentation & Control For HVAC

1.3 REFERENCES

A. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
B. UL 181 - Factory-Made Air Ducts and Connectors.
C. ARI 880 - Air-Conditioning and Refrigeration Institute Standard Rating Conditions for Air Terminals

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Section 230500.
B. Submit shop drawings and product data sheets indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate air flow, static pressure, and radiated sound power levels (2nd through 7th octave bands) at design maximum operating conditions.
C. Submit manufacturer's installation instructions.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.
B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data.
C. Include directions for resetting all control setpoints.

1.6 WARRANTY

A. Provide one year manufacturer's parts and labor warranty.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products manufactured by Trane, Carrier, Titus, Krueger, Nailor, or Price meeting these specifications.

B. Unit performance data must be Rated in Accordance with ARI Standard 880, and must display the ARI Symbol on all standard units.

2.2 PERFORMANCE

A. Unit performance shall meet or exceed performance scheduled on the drawings.

2.3 GENERAL

A. Identify each terminal unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory set air flow and minimum factory set air flow.

2.4 FABRICATION

A. Casings: Units shall be completely factory assembled, manufactured of corrosion protected welded steel, and fabricated with a minimum of 18-gauge metal on the high pressure (inlet) side of the VAV dampers and 22-gauge metal on the low pressure (outlet) side and unit casing.

B. Lining: Minimum 1/2 inch thick tuff-skin mat or aluminum foil-faced glass insulation, 1.5 lb/cu ft. density, meeting NFPA 90A requirements and UL 181 erosion requirements.

C. Assembly: Air volume damper, fans and controls in single cabinet.

2.5 VOLUME DAMPER
A. Air volume control dampers shall be factory calibrated and tested assembly consisting of air modulation dampers and extension for connection to control actuators. All actuator linkages shall be protected by a sheet metal enclosure. Unit shall maintain constant volume mixed air flow.

2.6 CONTROLS

A. Pneumatic Controls

1. Pneumatic operator shall be pressure independent proportional variable air volume control with pneumatic volume regulator. Independent minimum and maximum airflow setpoints at the volume regulator shall be factory calibrated per schedule.

2. Means for air balancing and pressure independent compensating for varying inlet static pressure shall be factory furnished and mounted.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION
SECTION 233713 - DIFFUSERS, REGISTERS & GRILLES

PART 1  GENERAL

1.1  WORK INCLUDED

A. Supply, Return, Transfer and Exhaust Air Devices and Accessories.

1.2  RELATED WORK

A. Section 230500 – Common Work Results For HVAC

B. Section 230593 - Testing, Adjusting and Balancing

C. Section 233100 - HVAC Ducts

D. Section 233300 - Duct Accessories

1.3  QUALITY ASSURANCE

A. Make air flow tests and sound level measurement in accordance with applicable ADC equipment test codes and ASHRAE standards.

B. Manufacturer shall certify cataloged performance and ensure correct application of air outlet types.

1.4  SUBMITTALS

A. Submit in accordance with Section 230500.

B. Submit product data and shop drawings covering each item together with schedule of outlets, listing cfm, neck velocity, NC level and Ak factor and air flow measurement procedures.

1.5  JOB CONDITIONS

A. Review requirements (including architectural drawings) of outlets as to size, finish, and type of mounting prior to submitting shop drawings and schedules of outlets.

B. Check location of outlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Products manufactured by Krueger, Tuttle & Baily, Titus, J&J, Price or Nailor, meeting these specifications are acceptable.

2.2 GENERAL REQUIREMENTS

A. Provide air devices equal in all respects to those scheduled on the drawings.

B. Rate units in accordance with ADC standards.

C. Base air outlet application on space noise level of NC 35 maximum in all areas unless indicated otherwise on drawings.

D. Provide supply outlets with sponge rubber seal around edge.

E. All devices shall be factory finished.

F. When required provide air devices factory installed in metal panels painted to match air device finish. Panel shall be suitable for insertion into lay-in-tile ceilings.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install items in accordance with manufacturer's printed instructions.

B. Paint ductwork visible behind air outlets matt black.

C. When required cut metal panels for insertion in ceiling at grid location where tiles may be less than nominal size. Center diffuser or grille within modified panel.

END OF SECTION
SECTION 233723 - WEATHERHOODS

PART 1   GENERAL

1.1 WORK INCLUDED
   A. Roof Mounted Weatherhoods

1.2 RELATED WORK
   A. Section 230500 – Common Work Results for HVAC
   B. Section 230593 – Testing, Adjusting & Balancing For HVAC
   C. Section 233113 – Ductwork
   D. Section 233300 – Air Duct Accessories

1.3 SUBMITTALS
   A. Submit product data including dimensional data, equipment weight, material specifications, capacity data in accordance with Section 230500.

PART 2   PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Products manufactured by Greenheck, Cook, Western Vent, ACME, Penn or Jenn-Air meeting these specifications are acceptable.

2.2 PERFORMANCE
   A. Weatherhood performance shall meet or exceed that scheduled on the drawings.

2.3 CONSTRUCTION
   A. Hood shall be constructed of heavy gauge aluminum sheets with rolled interlocking seams for reinforcement. Hood shall be constructed with galvanized steel braces to insure rigid assembly. Hood design shall insure weather tight construction.
   B. Provide 1/2" x 1/2" x 19 ga. galvanized steel mesh birdscreen.
C. Provide counterbalanced backdraft damper constructed of extruded aluminum. Damper shall be adjustable to open at a pressure differential of 0.01 inches w.g. or less. Insure access for field adjustment.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install weatherhood on roof curb fabricated or provided by hood manufacturer. Carefully coordinate exact curb dimension.

B. Connect to ductwork as specified in Section 233113.

END OF SECTION
SECTION 237413 - MODULAR, OUTDOOR, CENTRAL STATION AIR HANDLING UNITS

PART 1  GENERAL

1.1 WORK INCLUDED

   A. Factory Built Air Handlers

   B. ETL Listed and Labeled

1.2 RELATED WORK

   A. Section 230500 – Common Work Results for HVAC

   B. Section 230519 – Mechanical Piping Specialties

   C. Section 230523 – Valves For HVAC

   D. Section 230593 – Testing, Adjusting & Balancing For HVAC

   E. Section 230900 – Instrumentation & Control For HVAC

   F. Section 230901 – Variable Frequency Drives

   G. Section 232113 – Hydronic Piping

   H. Section 233113 – Ductwork

   I. Section 233300 – Air Duct Accessories

1.3 QUALITY ASSURANCE

   A. Provide fans bearing AMCA certified rating seal.

1.4 SUBMITTALS

   A. Submit shop drawings and product data in accordance with Section 230500.

   B. Submit coil capacity data, motor data and filter data.

   C. Submit fan curves showing fan performance with system operating point plotted on curves.
D. Submit dimensioned data.

E. Submit manufacturer’s installation instructions and maintenance and operating procedures.

1.5 REFERENCED STANDARDS

A. ASHRAE Test Standard 52-76.

B. UL listing for filters, Class 2.

C. ARI Standard 410.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Units manufactured by McQuay, Carrier, Trane, York meeting these specifications are acceptable.

2.2 TYPE AND PERFORMANCE

A. Provide draw-through design as indicated on contract drawings.

B. Unit shall meet or exceed the performance schedule on the drawings.

2.3 CASING

A. Unit shall be outdoor type

B. Mount equipment and support exterior steel panels from steel frame.

C. Unit shall be double-wall construction, consisting of a minimum of R13 insulation with 20 gauge G-90 galvanized steel exterior and 20 gauge G-90 galvanized solid interior liner. Provide perforated liners in fan section. Fan section shall be insulated with a minimum of R13 insulation under the liner.

D. Provide hinged access doors for access to sections and components requiring servicing. Doors shall be adequately sized to allow operating personnel to access unit. Provide gasket seals, door latch and handle assemblies.

E. Condensate drain pans shall be fabricated from 16 gauge 304 stainless steel. Drain pans shall be sloped for complete drainage with no standing water in the unit.
2.4 INSULATION

A. Insulate entire unit casing with 2 inch thick, 3 lb. density insulation.

2.5 FAN

A. Fan performance shall be based on tests run in an ARI certified laboratory and administered in accordance with ARI Standard 430.

B. All fans shall be statically and dynamically balanced including final trim balance at the factory for quiet operation.

C. Fans shall be DWDI housed. Fans shall not pass through their first critical speed before reaching operating RPM.

D. Provide solid steel fan shafts with self-aligning ball bearings having minimum average life of 200,000 hours. Extend lubrication fittings to exterior of fan casing.

E. Fan shall be isolated from unit with 1” minimum spring isolators.

2.6 ANGLE FILTER MIXING BOX

A. Angle filter mixing boxes shall be the standard product of the unit manufacturer complete with dampers in the return and outside air stream for mixing and adjusting the two air streams. Dampers shall be fully gasketed low leakage type equivalent to Ruskin MD-35. Provide suitable handles.

2.7 FILTER SECTION

A. Filters shall be provided with holding frames and all required hardware shall be serviceable from both sides of the unit.

B. Filters shall be 2” thick medium efficiency, disposable, pleated media type. The efficiency shall be an average of 30-35 percent by the ASHRAE Test Standard 52-76. Filters shall be UL listed, Class 2.

C. The media shall be a nonwoven cotton fabric and shall be reinforced with a wove scrim backing. The media support grid shall be welded wire with an approximate free area of 96 percent. The wire grid shall be bonded to the media.

D. The enclosure frame shall be constructed of a rigid heavy-duty chipboard secured to the air entrance and exit side of each pleat.
E. Holding frames shall be factory fabricated of 16 gauge minimum galvanized steel and shall be provided with gaskets and spring type positive sealing fasteners.

F. One set of filters shall be provided with the unit during construction and one set for testing and balancing of the unit.

2.8 COILS

A. Enclose coils in coil section with headers and U-bends fully contained within the casing.

B. Coils shall be removable from the unit without dismantling the unit. Water coil capacities, pressure drops and selection procedures shall be certified in accordance with ARI Standard 410. Coils shall have same end supply and return connections unless otherwise indicated. All coils shall be leak tested by the manufacturer.

C. Coils shall be of the extended surface type meeting all conditions and having the minimum face area and pressure drops scheduled on the drawings. Coils shall be constructed of 1/2" O.D. copper tubes and plate type aluminum or copper fins bonded to the tubes by mechanical expansion. Minimum acceptable tube thickness is 0.02" and minimum acceptable fin thickness is 0.008. Coil headers shall be constructed of close gained cast iron extra heavy copper or extra heavy red brass. The coil section shall be provided with a galvanized steel casing no lighter than 16-gauge. Galvanized intermediate tube support sheets shall be provided in coils having tube lengths in excess of 48" and on long coils the spacing of coil supports shall not exceed 48".

D. Maximum coil face velocity shall be 500 fpm. Maximum fin spacing shall be 12 fpi.

2.9 PIPE CHASE

A. Provide a 36" deep minimum internal pipe chase large enough to handle all valves and accessories.

2.10 ROOF CURB

A. Provide prefabricated galvanized steel curb designed and manufactured by the unit manufacturer. The roof curb shall support the entire perimeter of the unit. Curb shall be 14" high curb.

2.11 MOTORS AND DRIVES
A. Motors shall be mounted on an adjustable mount furnished by the unit manufacturer. Motors shall be open-drip-proof premium efficiency type with greasable ball bearings and of the voltage scheduled on the drawings.

B. Drives shall be V-belt type selected at 150 percent of motor horsepower. Units having up to and including 30 hp shall have variable pitch drives suitable for adjustment within 10% of scheduled rpm. Units having motors larger than 30 hp shall have constant speed drives selected at scheduled rpm. Manufacturer shall provide one additional constant speed motor sheave for each drive if required to rotate fans at proper rpm as determined by actual job conditions. Belt guard shall be provided by the unit manufacturer.

2.12 VIBRATION ISOLATORS

A. Provide 1” minimum, housed, spring vibration isolators under the fan assembly.

PART 3 EXECUTION

3.01 ASSEMBLY

A. Assemble fan by bolting sections together to make single unit.

3.02 INSTALLATION

A. Install items in accordance with manufacturer's instructions and as shown on the drawings.

B. Install unit on pre-manufactured roof curb, level and secured.

END OF SECTION
SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1  GENERAL

1.1  WORK INCLUDED

A.  Split-System Air-Conditioner

B.  Controls

1.2  RELATED WORK

A.  Section 230500 – Common Work Results for HVAC

B.  Section 230519 – Mechanical Piping Specialties

C.  Section 230593 – Testing, Adjusting & Balancing For HVAC

D.  Section 233300 – Air Duct Accessories

1.3  QUALITY ASSURANCE

A.  Meet the requirements of UL and applicable codes.

B.  Test and rate cooling systems to the appropriate ARI Standard.

1.4  REFERENCE STANDARDS

A.  ARI Standard 210/240 or 360 and 270.

B.  National Electrical Code.

1.5  SUBMITTALS

A.  Submit shop drawings and product data in accordance with Section 230500.

B.  Submit manufacturer's installation instructions.

C.  Submit manufacturer's descriptive literature including dimensions, capacity data, fan performance data, motor data and filter data.

D.  Submit schedule of actual unit performance data versus design unit performance data.
1.6 WARRANTY

A. Provide 5 year unconditional parts warranty on heat exchangers.

B. Provide 5 year unconditional parts warranty on compressor.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER'S

A. Units manufactured by Carrier, Trane, Mitsubishi, Sanyo, LG or others meeting or exceeding these specifications are acceptable.

2.2 TYPE AND PERFORMANCE

A. Units shall be self-contained, factory assembled and prewired with single point electrical connection. Indoor unit shall consist of cabinet and frame, supply fan, evaporator coil and all required and necessary safety and operating controls. Outdoor unit shall consist of compressors, condenser coil and fan(s) and all required and necessary safety and operating controls.

B. Units shall be suitable for indoor and outdoor use as required.

C. Unit shall meet or exceed the capacity scheduled.

2.3 EVAPORATOR-FAN UNIT

A Concealed Unit Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

1 Insulation: Faced, glass-fiber duct liner.

2 Drain Pans: Galvanized steel, with connection for drain; insulated.

3 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

B Floor-Mounting, Unit Cabinet: Enameled steel with removable panels on front and ends.

1 Discharge Grille: Steel with surface-mounted frame or welded steel bars forming a linear grille and welded into supporting panel.
2 Insulation: Faced, glass-fiber, duct liner.

3 Drain Pans: Galvanized steel, with connection for drain; insulated

4 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

C Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

D Water Coil: Copper-tube water coil, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; and having a 2-position control valve.

E Electric Coil: Helical, nickel-chrome, electric-resistance heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for over-current protection.

F Evaporator Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.

G Fan Motor: Multi-speed.

H Filters: Provide 1 inch thick, in fiberboard frames, Permanent or cleanable with ASHRAE 52.2 MERV rating of 6 or higher.

SCHEDULE 1 - AIR-COoled, COMPRESSOR-CONdENSER UNIT

A Casing steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

B Compressor: Hermetically sealed reciprocating or scroll type with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor. [Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch].

1 Refrigerant: R-410A.

C Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid sub-cooler.
D  Fan: Aluminum-propeller type, directly connected to motor.

E  Motor: Permanently lubricated, with integral thermal-overload protection.

F  Low Ambient Kit: Permits operation down to 0 deg F.

SCHEDULE 2 - ACCESSORIES

A  Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B  Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

   1  Minimum Insulation Thickness: 1/2 inch thick. Both liquid and suction lines must be insulated.

PART 3  EXECUTION

SCHEDULE 3 - INSTALLATION

A  Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

B  Install ground-mounted, compressor-condenser components on 4-inch thick, reinforced concrete base; 4 inches larger on each side than unit. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete." Coordinate anchor installation with concrete base.

C  Install ground-mounted, compressor-condenser components on polyethylene mounting base.

D  Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07. Anchor units to supports with removable, cadmium-plated fasteners.

E  Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 1 inch.

SCHEDULE 4 - CONNECTIONS

SPLIT SYSTEM AIR CONDITIONING UNITS 238126-4
A  Connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

B  Connect supply and return condenser connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

C  Install piping adjacent to unit to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

D  Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

E  Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new components, and retest.

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

END OF SECTION
SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:
   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following) [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Carbon steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Extend sleeves to unistrut support on both surfaces of walls.

F. Extend sleeves installed in floors 4" (inches) (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.
3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260500
SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits

1.3 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. 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 NFPA 70.

1.5 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.
3. General Cable Corporation.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN, and XHHW.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Minimum circuit conductor size shall be No. 12.

D. Vibrating and rotating equipment and controls: Copper. Stranded for No.10 and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway or Type XHHW, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspace: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway.
3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS

A. 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.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   2. For sleeve rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Sleeves shall extend past wall and shall be supported by metal framing on both side of wall.

G. Extend sleeves installed in floors 4" (inches) (50 mm) above finished floor level.

H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance, feeder and branch circuit conductors for compliance with requirements. Provide continuity and insulation testing on all feeder and branch circuit conductor. Insulation testing shall be performed with a 500 VDC megger. Phase and neutral conductors shall be test free of short-circuits and grounds. For continuity testing, motor feeders shall be measured with motors connected and local disconnect closed; readings shall be one phase-to-ground for each phase. Test all other conductors phase-to-phase and phase-to-ground.


3. Provide testing of proper phase rotation for three-phase system. Provide individual tests at all service entrance, motor control center and other sources that feed equipment that may be adversely affected by incorrect phase rotation, especially rotating machines.
C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
4. The contractor shall furnish the instruments, materials, and labor for all tests at no additional cost to the owner (i.e., it must be part of the bid price). Contractor shall present to the owner three copies of certified test reports. In addition to the various electrical measurements results, the test reports shall, at minimum, include the official City of Tucson FD&M project name, the project address, City of Tucson building number, City of Tucson FD&M A/E Section project number, name of the test, name of the equipment tested, location in the building of the equipment tested, Project General contractor, Contractor performing the test, date, time, and temperature. The City Electrical Engineer desires that the contractor use pre-printed industry form, if available, for recording and reporting electrical test. The City Electrical Engineer expects the test results to be reported in a reasonable, easily read format and expects the use of good common English, accurate spelling and good penmanship in the reports. The City Electrical Engineer reserves the right to reject test reports that are difficult to interpret. This does no exclude using narrative to explain the test reports, methods and unusual field circumstances that may contribute to difficult testing situations.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519
SECTION 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Ground rods.
2. Grounding arrangements and connections for separately derived systems.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems, based on NFPA 70B.

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a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

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2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel 3/4 inch in diameter by 10 feet (19 mm by 3 m).

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical telephone equipment rooms as indicated in "T" series drawings.
   1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
D. Water Heater: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. For grounding electrode system, install at least two rods spaced at least 6' from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building’s main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

H. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 250 kcmil AWG.

1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below...
grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.
3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment: 5 ohms.
2. Pad-Mounted Equipment: 5 ohms.
3. Maximum ground-resistance value 5 ohms.

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer’s standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer’s standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c., in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps MSS Type 19, 21, 23, 25, or 27, complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Support ceiling outlets boxes from ceiling structure. Support boxes in suspended ceiling systems from main runner channels, or joist, or other structural members. For boxes in suspended ceilings, supplements outlet box support with separate support to the structure as required for the expected load of the device, such a ceiling fan.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 260529
SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.

2. For handholes and boxes for underground wiring, including the following:
a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.
c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Coordination Drawings: Conduit routing plans, 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. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

D. Qualification Data: For professional engineer and testing agency.

E. Source quality-control test reports.

1.5 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 NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Aflflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.
D. EMT: ANSI C80.3.

E. FMC: Zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket.

G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   2. Fittings for EMT: compression type, steel. Set screw fittings are not allowed.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

H. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. CANTEX Inc.
   3. Electri-Flex Co.
   4. Lamson & Sessions; Carlon Electrical Products.
   5. Manhattan/CDT/Cole-Flex.
   6. RACO; a Hubbell Company.
   7. Thomas & Betts Corporation.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

D. LFNC: UL 1660.

E. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: UL 514B.
2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Thomas & Betts Corporation.
      c. Wiremold Company (The); Electrical Sales Division.

   2. The surface raceways shall be supplied as a complete system using accessories and fittings of the same manufacturer.

2.5 BOXES, ENCLOSURES, AND CABINETS

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

   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
7. RACO; a Hubbell Company.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover. Boxes in wall shall be 4" X 4" metal box with single mud ring. Exterior and surface boxes shall be waterproof deep bell.

D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized with gasketed cover.

G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Cabinets and enclosures shall have blank ends and sides, no knockouts. The contractor shall punch out openings required. All unused openings shall be plugged with manufactured plugs.
   3. Do not use single covers for junctions and pull boxes having cover length or width dimension exceeding three feet unless so approved. Sectionalize covers exceeding three feet in either dimension into two or more sections.

H. Cabinets:
   1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Cabinets and enclosures shall have blank ends and sides, no knockouts. The contractor shall punch out openings required. All unused openings shall be plugged with manufactured plugs.
   7. All cabinets and enclosures shall have a protective pocket inside the front cover with schematic diagram, connection diagram, and/or as applicable
layout drawing of wiring and components within enclosures or boxes that contain electrical equipment, terminal strips and the like.

8. All cabinets and enclosures that contain equipment like relays, terminal boards or terminal trips shall have hinged covers.

2.6 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.7 SLEEVE SEALS

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

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
5. Application of Handholes and Boxes for Underground Wiring:
   a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
   b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
   c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: Rigid steel conduit.
3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: Rigid steel conduit.
7. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air.
8. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: IMC.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 1-inch (25.4-mm) trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit or max 270 degrees deflection.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
H. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Change from ENT to RGS conduit before rising above the floor.

I. All underground conduit elbows (sweeps) shall be rigid steel, ½" wrapped with two layers of 10 mil PVC tape applied for corrosion protection. Do not allow PVC or PVC coated steel elbows.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
   1. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
   2. Install with a maximum of three 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
   1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
   2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
   1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.

3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

S. All panelboards shall have a minimum of (1) 3/4" spare conduit for each equivalent 3-pole spare or space stubbed out to a readily accessible location. Each 200 Amp panelboard shall have at least one 1 3/4" spare conduit stubbed out to a readily accessible location.

T. Install hubs and box connectors at conduit-to-enclosure connections.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

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B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Sleeves shall extend past wall and shall be supported by Unistrut on both sides of wall.

G. Extend sleeves installed in floors 4" (inches) (50 mm) above finished floor level.

H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm)
annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533
SECTION 260543 UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.
PVC: Polyvinyl chloride

1.4 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.


C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Cover design.
4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

E. Qualification Data: For professional engineer and testing agency.

F. Source quality-control test reports.

G. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

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

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 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.

PART 2 - PRODUCTS

2.1 CONDUIT

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by
same manufacturer as the conduit, complying with NEMA TC 3 and
UL 514B.

2.2 NONMETALLIC DUCT ACCESSORIES

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

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

1. Cantex, Inc.
2. Electri-Flex Company.
3. Lamson & Sessions; Carlon Electrical Products.
4. Manhattan/CDT; a division of Cable Design Technologies.
5. Spiraduct/AFC Cable Systems, Inc.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers,
sized for type and sizes of ducts with which used, and selected to
provide minimum duct spacings indicated while supporting ducts
during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in
Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by
600 by 76 mm) in size, manufactured from 6000-psi (41-MPa)
concrete.
   b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high,
      3/8-inch- (10-mm-) deep letters.

2.3 PRECAST CONCRETE HANDDOLES AND BOXES

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

B. Manufacturers: Subject to compliance with requirements, provide
products by one of the following:
1. Christy Concrete Products.
2. Utility Vault Co.
3. Precast Company.
4. Wausau Tile, Inc.
5. Pencell

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.
4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
   a. Cover Hinges: Concealed, with hold-open ratchet assembly.
   b. Cover Handle: Recessed.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC." or "COMMUNICATIONS." As indicated.
7. Configuration: Units shall be designed for flush burial and have open or closed bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
   a. Extension shall provide increased depth of 12 inches (300 mm) per extension.
b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
   a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
   b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
   c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

11. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank, unless otherwise indicated.
B. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO, H-20 structural load rating.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 22 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."
3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use manufactured RGS (coated or tape wrapped) long sweep bends with a minimum radius of 12.5 feet (4 m), both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer’s written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

   1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.

   2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.

   3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical/Common Work Results for Communications/Common Work Results for Electronic Safety and Security."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install, unless otherwise specified, 1250# muletape in spare innerducts & 2500# muletape in spare conduits.

H. Concrete-Encased Ducts: Support ducts on duct separators.
1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

   a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

   b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.

7. Depth: Install top of duct bank at least 36 inches (914.4 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.

9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

10. Warning Tape: An electronically detectable 6" Fiber Warning tape shall be installed 18" above the conduit. Tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with a minimum thickness of 0.004 inch. The tape shall have a minimum strength of 7500 PSI lengthwise and 1,500 PSI crosswise. The tape shall be manufactured with integral wires, foil backing, or other means to enable its detection by a metal detector when the tape is buried up to a depth of 3 feet deep. The tape shall be orange in color and have the following continuous inscription, "CAUTION - FIBER OPTIC CABLE BURIED BELOW". The inscription shall be 2-inch black letters. The power tape shall have a continuous message in permanent ink formulated for prolonged underground use and bear the words, "CAUTION—ELECTRIC LINE BURIED BELOW" in black letters on red background.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891, unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:

Underground Ducts and Raceways
1. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.

2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.

3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

4. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes. Waterproofing materials and installation are specified in Division 07 Section "Elastomeric Sheet Waterproofing." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars.

F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.