

February 11, 2020

**Administration Building Renovation and Addition  
Aza Health**

Architect's Job Number: 010R07

**ADDENDUM 2**

All items in the Addendum are incorporated into the Contract Documents.

**Item 1.**

Questions received from Plan Holders:

Q1: Will temporary fencing be required?

A1: Yes, temporary fencing will be required around the addition when the existing building is occupied. See Section 01 56 00 – Temporary Barriers and Enclosures (Attachment A)

Q2: Drawing A403 shows a projector in room 101; however, I could not find any projection screen on the drawings or in the specifications. Please clarify.

A2: See Section 11 52 13 – Projection Screens (Attachment B)

Q3: Drawing A104 in room 65 shows a 'ss corner guard' noted. This is the only note that indicates wall protection. Is this typical or isolated? Please provide a specification and clarify scope.

A3: Delete S.S. Corner guard note from A104 Room 65.

Q4: On Drawing A600 both the door schedule and room finish schedule are incomplete. Please provide details.

A4: A revised door and finish schedule were provided in Addendum No. 1.

Q5: Specification Section 07 21 16 – Insulation paragraph 2.7 (A) OPEN CELL FOAM INSULATION calls for 'R-20, M01 based polyurethane semi-rigid foam insulation, coated with an approved thermal barrier.' Drawing A502 shows 4.5" rigid insulation at the roof of the new building." There are no cuts through the existing building. Is the insulation supposed to be applied to the underside of the existing building's roof deck? Please clarify.

A5: Open cell foam insulation is not required to be applied on this project.

Q6: Drawing A011 is a survey dated 11/08/2011. This site does not appear to have a retention pond. Has the additional impervious surface (addition) been run through SJRWMD?

A6: The retention is located between the building and the road. A modification to the existing permit is required. CRG is working on this modification.

Q7: Will material testing be required to be part of the construction agreement?

A7: Yes, material testing is required

Q8: Specification Section 06 20 00 – Finish Carpentry paragraph 2.2 (B) calls for a bunch of exterior finish carpentry that is not shown on the drawings. Please clarify.

A8: Section 06 20 00 – Finish Carpentry, 2.2 Materials, Delete paragraph B. Exterior Finish Carpentry.

Q9: Is the stucco painted or integral color? Please clarify scope.

A9: Stucco shall be integral color. Stucco shall be applied at the entrance columns of the addition, the soffit at the entrance on the addition, and at the existing exterior wall where windows are being removed.

Q10: For the bid bond that will be submitted with our proposal – Section 00 63 33 Supplemental Instructions to Bidders page 00 63 33-4 paragraph B.5. it states " The words "5% of the Bid" are not sufficient and will require re-execution of the Bond. Please clarify what is sufficient.

A10: The actual dollar amount of the bond shall be listed .

Q11: Will the bid turn in date be extended, or will it remain the same for Feb 21?

A11: The bid date will remain the same.

Q12: Regarding Q19 on Addendum No. 1, there is no A010 in the plan set please provide.

A12: Sheet A010 is included in this addendum as Attachment C

**Item 2.**

Division 22, Plumbing is included in this addendum as Attachment D. Add this attachment to the Project Manual.

**Item 3.**

Division 23, HVAC is included in this addendum as Attachment E. Add this attachment to the Project Manual.

**Item 4.**

Division 26, Electrical is included in this addendum as Attachment F. Add this attachment to the Project Manual.

**Item 5.**

Division 28, Electronic Safety and Security is included in this addendum as Attachment G. Add this attachment to the Project Manual.

**Item 6.**

An updated Table of Contents is included in this addendum as Attachment H. Add this attachment to the Project Manual.

End of Addendum No. 2

**SECTION 01 56 00**

**TEMPORARY BARRIERS AND ENCLOSURES**

**PART I - GENERAL**

1.1 SUMMARY

- A. Use of Barriers and Enclosures: The Contractor shall furnish, erect and maintain temporary barriers, barricades, enclosures, and temporary construction fencing as required for the following:
  - 1. To protect the health and safety of occupants and the general public from exposure to immediate physical harm as well as to noise, dust, and fumes. Note that this Section does not provide minimum requirements related to Indoor Air Quality.
  - 2. To protect new and pre-existing adjacent construction from exposure to physical damage, dust, dirt, and water.
  - 3. To provide security of valuable property.
  - 4. To protect trees and plants.

**PART 2 - PRODUCTS**

2.1 GENERAL FABRICATION

- A. Substantial Construction: Barriers and enclosures shall be of adequately substantial construction to serve their purpose without failure throughout the duration of their use. Materials may be new or used, suitable for the intended purpose, but shall not violate requirements of applicable codes and standards.
- B. Rigid Fencing: The general public, as well as adjacent lawns and plantings, shall be protected from harm by the installation of continuous, durable, rigid fencing at the limit lines of each construction area.
- C. Tree Protection: Existing trees that are adjacent to a construction site shall be protected from damage by the installation of durable, rigid 6' high fencing at the drip line of each tree.

**PART 3 - EXECUTION**

3.1 BASIC REQUIREMENTS

- A. Install facilities of a neat and reasonable uniform appearance, structurally adequate for required purposes.
- B. Install barriers and enclosures so as to not create new hazards such as tripping or protrusions that might be a source of safety concern to pedestrians or passersby.
- C. Establish reasonable alternative access when necessary due to placement of barriers.
- D. Maintain barriers during entire construction period.
- E. Relocate barriers as required by progress of construction.

3.2 TREE AND PLANT PROTECTION REQUIREMENTS

- A. Preserve and protect existing trees and plants at site which are designed to remain, and those adjacent to site.
- B. Consult with Architect and the Owner for removal of agreed-on roots and branches which interfere with construction.
  - 1. Employ a qualified tree surgeon to remove, and to treat cuts.
- C. Provide temporary barriers to a height of six feet, around each, or around each group, of trees and plants. The barriers shall be placed at the drip line of each tree.
- D. Protect root zones of trees and plants:
  - 1. Do not allow vehicular traffic or parking.
  - 2. Do not store materials or products.

3. Prevent dumping of refuse or chemically injurious materials or liquids.
4. Prevent puddling or continuous running water.

E. Carefully supervise excavating, grading and filling, and subsequent construction operations, to prevent damage.

F. Replace, or suitably repair, trees and plants designated to remain which are damaged or destroyed due to construction operations. Any damage and any necessary replacements will be evaluated by licensed horticulturists.

### 3.3 REMOVAL

A. Completely remove barricades, including foundations, when construction has progressed to the point that they are no longer needed, and when approved by the Owner or Architect

B. Clean and repair damage caused by installation, fill and grade areas of the site to required elevations and slopes, and clean the area.

END OF SECTION

**SECTION 11 52 13**

**PROJECTION SCREENS**

**PART 1 – GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Manually operated, wall-mounted projection screens.
  - 2. Related accessories.
- B. Related Sections:
  - 1. Section 09 21 16 - Gypsum Wallboard
  - 2. Section 09 51 13 - Acoustical Ceilings

1.2 REFERENCES

- A. Forest Stewardship Council:
  - 1. FSC Guidelines - Forest Stewardship Council Guidelines.
- B. National Fire Protection Association:
  - 1. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.3 SUBMITTALS

- A. Shop Drawings: Submit detailed drawings indicating mounting dimensions, method of attachment, and locations.
- B. Product Data: Submit manufacturer's product data on materials, finishes, and operation of unit.
- C. Manufacturer's Installation Instructions: Submit detailed installation instructions including rough in measurements.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
  - 1. Submit parts catalog with complete list of equipment replacement parts; identify each entry with equipment description and identifying code.
  - 2. Submit technical information for servicing equipment.

1.5 QUALITY ASSURANCE

- A. Flame Resistant Fabrics: Passes when tested in accordance with NFPA 701, Test 1 or Test 2.
- B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum 3 years documented experience approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver projection screens after building is enclosed, other work within spaces where screens are to be installed is substantially complete, and installation of screens is ready to take place.
- B. Protect projection screens from damage before, during and after installation.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Coordinate installation of ceilings, walls, and location.

**PART 2 - PRODUCTS**

2.1 PROJECTION SCREEN

- A. Da-Lite, Model C W/CSR 130D 69x110 MW
- B. Locations as indicated on Drawings.

**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. Verify conditions are acceptable for installation.

3.2 INSTALLATION

- A. Install projection screens at location indicated on Drawings.
- B. Coordinate installation with wall finishes.
- C. Securely anchor to supporting substrate.
- D. Install to produce smoothly operating screen with plumb and straight vertical edges and plumb and flat viewing surfaces when lowered.

3.3 ADJUSTING

- A. Adjust installed unit for smooth and balanced operation.

3.4 CLEANING

- A. Remove protective coverings from finished surfaces. Clean surfaces and components ready for inspection.

END OF SECTION

**MATERIAL LEGEND**

	PARTITION
	PARTITION WALL WITH SOUND BATTS
	BATT INSULATION
	RIGID INSULATION
	FINISHED WOOD
	DIMENSIONAL LUMBER
	WOOD BLOCKING
	EARTH
	C.M.U. WALL
	CAST-IN-PLACE CONCRETE
	REINFORCED VERTICAL CMU CELL

**GENERAL NOTES**

1. ALL WORK AND IMPROVEMENTS ARE CONFINED TO THE AREAS INDICATED IN THESE DRAWINGS. ALL WORK WILL BE INSTALLED BY A LICENSED CONTRACTOR AND THE APPROPRIATE LICENSED SUBCONTRACTORS IN STRICT ACCORDANCE WITH ALL GOVERNING CODES.

2. ALL WORK IS TO BE EXECUTED UNDER DIRECT SUPERVISION OF A CERTIFIED GENERAL CONTRACTOR. THE GENERAL CONTRACTOR SHALL VERIFY ALL SITE CONDITIONS, DIMENSIONS, AND COORDINATE ALL OPENINGS AND INSERTS WITH THE APPROPRIATE SUBCONTRACTORS. HANGING DEVICES SHALL BE INSTALLED SO AS NOT TO OVERLOAD THE ASSEMBLY OR ANY OTHER STRUCTURAL COMPONENTS. IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO DETERMINE ERECTION PROCEDURE AND SEQUENCE TO ENSURE THE SAFETY OF THE BUILDING, ITS COMPONENTS, AND ALL PRESENT ON THE SITE.

DIMENSIONS: ALL DIMENSIONS AND ELEVATIONS SHOWN ON THE DRAWINGS SHALL BE VERIFIED BY THE CONTRACTOR TO INSURE THE PROPER INTERFACING WITH EXISTING CONDITIONS. IF ANY CONFLICT OCCURS BETWEEN ANY PART OF THESE DOCUMENTS THE CONTRACTOR IS TO NOTIFY THE ARCHITECT IMMEDIATELY. IF THE ARCHITECT IS NOT AFFORDED THE OPPORTUNITY TO CLARIFY OR MODIFY ANY CONFLICTS, THE CONTRACTOR ASSUMES RESPONSIBILITY FOR RESOLVING ANY PROBLEMS WHICH MAY HAVE DEVELOPED.

RESPONSIBILITY: IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO DETERMINE ERECTION PROCEDURE AND SEQUENCE TO INSURE THE SAFETY OF THE BUILDING AND ITS COMPONENT PARTS DURING ERECTION. THIS INCLUDES BUT IS NOT LIMITED TO THE ADDITION OF WHATEVER TEMPORARY BRACING, GUYS, OR TIE DOWNS THAT MAY BE NECESSARY. SUCH MATERIAL SHALL BE REMOVED AND SHALL REMAIN THE PROPERTY OF THE CONTRACTOR AFTER COMPLETION OF THE PROJECT. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE THE MEANS AND METHODS REQUIRED TO ACHIEVE THE INTENT OF THESE DRAWINGS.

CONFLICTS: WHERE CONFLICTS OCCUR BETWEEN THE SPECIFICATIONS, REFERENCED CODES, NOTES, AND WORKING DRAWINGS, THE MOST STRINGENT REQUIREMENTS SHALL APPLY. IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO NOTIFY THE ARCHITECT IMMEDIATELY OF ANY CONFLICTS FOR DIRECTION.

COORDINATION: GENERAL CONTRACTOR SHALL COORDINATE ALL OPENINGS AND INSERTS WITH THE APPROPRIATE SUBCONTRACTORS ACCORDING TO THE PLANS. SEE SHOP DRAWINGS FOR ALL SUPPORTING STRUCTURES AND INSERTS REQUIRED BY THE VARIOUS BUILDING SYSTEMS. ALL SUPPORT STRUCTURES AND HANGING DEVICES SHALL BE INSTALLED SO AS NOT TO OVERLOAD THE STRUCTURE OR ANY STRUCTURAL COMPONENT. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SAFETY OF THE STRUCTURE AND ITS OCCUPANTS.

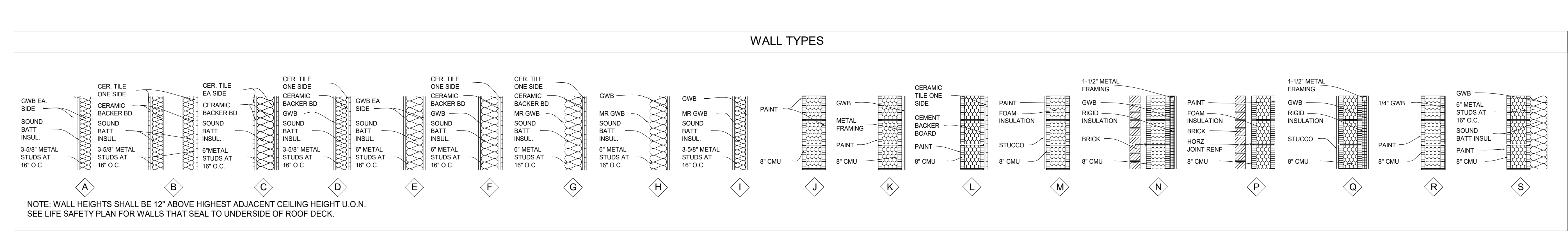
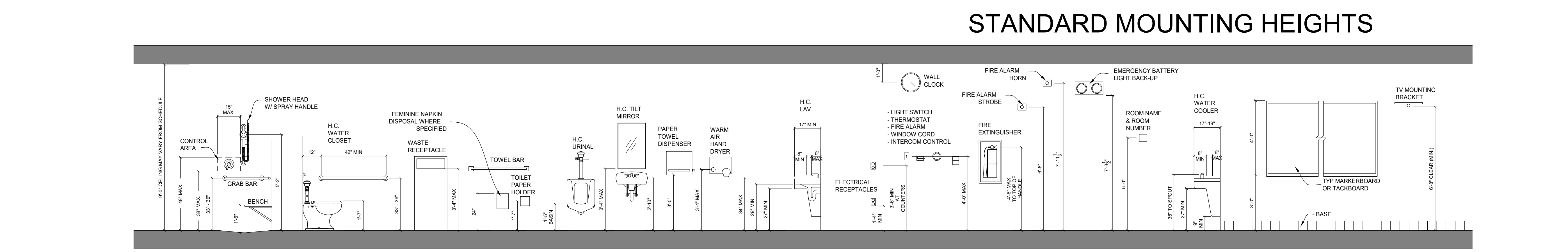
SUBMITTALS: THE REVIEW OF VARIOUS SUBMITTALS BY THE VARIOUS SUBCONTRACTORS AND PRE-ENGINEERED SYSTEMS ENGINEER OF RECORD WILL BE TO VERIFY THAT THE SUBMITTALS HAVE BEEN FURNISHED AND PREPARED BY A QUALIFIED PERSON, THAT THE PREPARER HAS UNDERSTOOD THE INTENT OF THE DESIGN AND THE CONSTRUCTION DOCUMENTS. NO DETAILED REVIEW WILL BE MADE BY THE ARCHITECT AND ENGINEER. THE GENERAL CONTRACTOR SHALL CHECK AND STAMP THE SHOP DRAWINGS INDICATING THAT A THOROUGH REVIEW WAS CONDUCTED AND STAMPED FOR CONFORMANCE PRIOR TO FORWARDING THEM TO THE ARCHITECT. THE ARCHITECT / ENGINEER WILL REVIEW THE SHOP DRAWING SUBMITTAL ONCE AND IF FOUND NOT TO BE IN CONFORMANCE, THE SUBMITTAL WILL BE REJECTED. ADDITIONAL REVIEWS CAN BE PERFORMED FOR THE COST BURDEN DIRECTLY RELATED TO THE ADDITIONAL REVIEW. FOR COLOR SELECTION, THE CONTRACTOR IS TO SUBMIT ALL COLOR RELATED PRODUCTS AT ONE TIME TO INSURE CONTINUITY IN THE OVERALL COLOR SCHEME USED.

**GRAPHIC SYMBOLS**

	DOOR MARK		SECTION/DETAIL TARGET
	WALL MARK		ELEVATION REFERENCE
	WINDOW MARK		WALL OR PARTIAL BUILDING SECTION
	ROOM SPACE NUMBER		CROSS OR BUILDING SECTION
	EXIT LIGHT (ILLUMINATED)		NORTH ARROW (TRUE)

**LIST OF ABBREVIATIONS (ALPHABETIZED)**

A.B. ABOVE	ANCHOR BOLT	C.T. CTR.	CERAMIC TILE	G. GAS	MIR. MISC.	MIRROR	RVS. REVERSE
ACC. ACCESS	ACCOUS. ACOUSTICAL	C.W. COLD WATER	ACCESS	GAL. GALLON	MLD. MILD	MISCELLANEOUS HOLDING	
AD. ADRESUM	AIR CONDITIONING	C.F.T. CUBIC FEET	AIR	GALV. GALVANIZED	M.O. MASONRY OPENING		S. SOUTH
ADH. ADHESIVE	AREA DRAIN	C.YD. CUBIC YARD	ADJUSTABLE	G.B. GENERAL CONTRACTOR	MOD. MODULAR		S4S. SURFACED FOUR SIDES
ADJ. ADJUST	ADDRESS		AGGREGATE	G.C. GENERAL CONTRACTOR	MOV. MOVABLE		SN. SANITARY
A.F.F. ABOVE FINISHED FLOOR	ADHESIVE		AGGREGATE	GD. GRADE	MR. MOISTURE RESISTANT		S.B.C. SOUTHERN BUILDING CODE
AGG. AGGREGATE	ADJUSTABLE		AGGREGATE	G.I.T. GLAZED INTERIOR TILE	MT. MOUNTED		SC. SOLID CORE
A.H.U. AIR HANDLING UNIT	ADJUSTABLE		AGGREGATE	G.T. GASKET	MTL. MATERIAL		S.C. SEALED CONCRETE
ALUM. ALUMINUM	ADJUSTABLE		AGGREGATE	G.O.V.T. GOVERNMENT	MULL. MULLION		SCH. SCHEDULED
ALT. ALTERNATE	ADJUSTABLE		AGGREGATE	G.S. GALVANIZED PIPE	MCN. MICROWAVE		SCN. SCREEN
AMP. AMPERE	ADJUSTABLE		AGGREGATE	GR. GRANITE			SD. STORM DRAIN
ANC. ANCHOR	ADJUSTABLE		AGGREGATE	G.R.V. GRAVEL STOP			SEC. SECTION
ANC. ANCHOR	ADJUSTABLE		AGGREGATE	G.W. GYPSUM WALLBOARD			SERV. SERVICE
ANL. ANGLE	ADJUSTABLE		AGGREGATE		N. NORTH		SGL. SINGLE
AND. ANODIZED	ADJUSTABLE		AGGREGATE		NA. NOT APPLICABLE		SH. SHEET
A.P. ACCESS PANEL	ADJUSTABLE		AGGREGATE		NAT. NATURAL		SHT. SHEATHING
APX. APPROXIMATE	ADJUSTABLE		AGGREGATE		N.I.C. NOT INCLUDED IN THIS CONTRACT		SM. SIMILAR
ARCH. ARCHITECTURAL	ADJUSTABLE		AGGREGATE		N.O.M. NOMINAL		SN. SAW JOINT
ASB. ASBESTOS	ADJUSTABLE		AGGREGATE		N.R. NOISE REDUCTION		SKY. SKYLIGHT
ASPH. ASPHALT	ADJUSTABLE		AGGREGATE		N.T.S. NOT TO SCALE		SL. SLEEVE
ATTN. ATTENTION	ADJUSTABLE		AGGREGATE		OA. OVERALL		SP. SOUNDPROOFING
A.T. ACOUSTICAL TILE	ADJUSTABLE		AGGREGATE		O.A. OUTSIDE AIR		SPEC. SPECIFICATION
AUTO. AUTOMATIC	ADJUSTABLE		AGGREGATE		OBS. OBSCURE		SPK. SPEAKER
@	ADJUSTABLE		AGGREGATE		ON CENTER		SQ. SQUARE
	ADJUSTABLE		AGGREGATE		O.D. OUTSIDE DIAMETER		SQ. FT. SQUARE FEET
	ADJUSTABLE		AGGREGATE		OFF. OFFICE		SS. SERVICE SINK
	ADJUSTABLE		AGGREGATE		OFF. OVERHEAD		SS. STAINLESS STEEL
	ADJUSTABLE		AGGREGATE		O.H. OVERHANG		STD. STANDARD
	ADJUSTABLE		AGGREGATE		O.J. OPEN-WEB JOIST		STR. STRUCTURE
	ADJUSTABLE		AGGREGATE		OP.F. OPPOSITE HAND		SUB. SUBCONTRACTOR
	ADJUSTABLE		AGGREGATE		OPP. OPPOSITE		SUSP. SUSPENDED
	ADJUSTABLE		AGGREGATE		SYM. SYMMETRICAL		SYS. SYSTEM



NOTE: WALL HEIGHTS SHALL BE 12" ABOVE HIGHEST ADJACENT CEILING HEIGHT U.O.N. SEE LIFE SAFETY PLAN FOR WALLS THAT SEAL TO UNDERSIDE OF ROOF DECK.

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Project Status

**ABBREVIATIONS & LEGENDS**

RENOVATIONS & ADDITION TO AZA HEALTH ADMINISTRATION BLDG.

Seal / Signature

**Addendum No. 2 Attachment C**

Project number	010R06
Date	1/29/20
Drawn by	Author
Checked by	Checker

**A010**  
 OF SHEETS  
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**SECTION 22 01 00**

**GENERAL PLUMBING PROVISIONS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

**1.2 SCOPE OF DIVISION**

- A. Work shall include all materials, equipment and labor necessary for a complete and properly functioning plumbing installation in accordance with all applicable codes, and contract drawings and specifications. Work shall include all work specified in Division-22, Plumbing.
- B. Pay for all required licenses, fees, inspections and permits.

**1.3 RELATION TO OTHER WORK**

- A. Work Not in Division 22: Related work not included in this division consists of requirements given in the following as may be included in the contract documents:
  - 1. Other divisions which may include work (such as concrete, steel, painting, ceiling systems, structure and other work) related to the work of Division 22.
- B. Work of Division 22: Any or all sections of Division 22 may include a paragraph or paragraphs under the heading, "Relation to other Work". Where such a paragraph is indicated and work directly related to the section is listed or described, such work shall be considered as relating directly to the indicated section. Any related work (directly related or otherwise) which may be omitted by reference from the "Relation to Other Work" paragraph of such section(s), shall be provided as necessary and required whether or not such work is included by reference. Such listing or description of related work within a section is given only as a convenience to the Contractor; omission of other related sections or described work does not in any way exclude the provision of such work.
- C. The Plumbing contractor shall coordinate with the controls vendor for all control related equipment that is provided by the controls vendor and installed by the Plumbing contractor.

**1.4 CODES**

- A. Install all work in accordance with the latest edition of all applicable regulations and governing codes, including the regulations of the utility companies serving the project.
- B. Where a conflict in code requirements occurs the more stringent requirement shall govern.

**1.5 STANDARDS**

- A. All equipment and devices shall bear U.L. label, the label of an industry recognized approved testing agency or A.G.A. certification for said item of equipment or device.
- B. All electrical devices must be U.L. approved.

**1.6 DRAWINGS**

- A. Architectural and structural drawings take precedence over plumbing drawings with reference to the building construction. Plumbing drawings are diagrammatic and indicate the general arrangement and extent of work. Architectural drawings indicate more exactly the desired relationship between diffusers, registers, lighting fixtures, equipment, electric panels and devices, plumbing fixtures, and other items which remain exposed in the completed building. Exact locations and arrangement of materials and equipment shall be determined, with the acceptance of the Architect/Engineer, as work progresses to conform in the best possible manner with the surroundings and with the adjoining work of other trades. Where locations of equipment, devices or fixtures are controlled by architectural features, establish such locations by referring to dimensions on Architectural drawings and not by scaling drawings.



1.7 DISCREPANCIES

- A. In case of differences between drawings and specifications, or where drawings and specifications are not clear or definitive, the more stringent requirement shall apply. Any such discrepancies shall be referred to Architect/Engineer for clarification and instructions.

1.8 ELECTRICAL PROVISIONS

- A. Work of Division 22 shall include the electrical requirements which are indicated to be integral with plumbing work and which can be summarized to include (but not necessarily be limited to) the following:
1. Motors
  2. Unless shown otherwise, motor starters are to be furnished by plumbing contractor, installed by electrical contractor.
  3. In lieu of the plumbing contractor furnishing motor starters, the plumbing contractor can coordinate with the electrical contractor where the electrical contractor furnishes and installs a combination motor starter / disconnect switch.
  4. Control switch, pilot lights, interlocks and similar devices.
  5. Electrical heating coils and similar elements in plumbing equipment.
  6. Electrical work specified in Division-22 for the HVAC control system.
  7. Drip pans to protect electrical work.
- B. Motors, Starters, Switches:
1. All motors 1HP and above associated with plumbing equipment that are not being provided with a variable frequency drive shall be provided with a motor starter.
  2. For motors under 1HP that are required to be controlled shall be coordinated with the building automation system to ensure start / stop control is achieved. Provide all relays, wiring and devices as required to achieve desired control.
- C. Drip Pans: Where possible, do not run plumbing piping directly above electrical (or electronic) equipment which is sensitive to moisture; otherwise provide drip pans under plumbing piping. Locate pan below piping and extend 6" on each side of piping and lengthwise 18" beyond equipment. Fabricate pans 2" deep, of reinforced sheet metal with rolled edges and soldered or welded seams; 20 gage copper, or 16 gage steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged to a waste receptor.

1.9 ELECTRICAL/PLUMBING WORK

- A. Definitions: Definitions for the purpose of Plumbing/electrical control and power coordination are as follows: (Note: The use of the words, "Provide", "furnish" and "install" are intended only for use in describing the coordination indicated by this paragraph and do not necessarily have the same definitions when used outside of the context of this paragraph.) Any items which do not fall within the scope of this paragraph shall be coordinated as individually specified.
1. "Furnish" means to procure an item and to deliver it to the project for installation.
  2. "Install" means to determine (in coordination with others as necessary) the appropriate intended location of an item and to set and connect it in place.
  3. "Provide" means to both furnish and install.
  4. Power Circuit: Circuit which carries main electric power to apparatus to which the power circuit is connected.
  5. Control Circuit: Circuit which carries electrical signals directing the performance of a controller, but which does not carry the main electric power. (See NEC, Section 430-71.) Such circuits shall also include those which serve a dual control and power function (e.g., a line voltage thermostat circuit which both activates and powers a small fan motor).
  6. Controller: A device, or group of devices, which serves to govern, in some predetermined manner, electric power delivered to apparatus to which the controller is connected and includes any switch or device normally used to start and stop a motor. (See NEC, Article 100, Definitions, "Controller", and Section 430-81(a).)
  7. Control Device: A device which reacts to an operating condition (pressure, temperature, flow, humidity, etc.) and which initiates transmission of an electrical control signal which causes operation of a controller or which causes operation of pressure switches, etc.
  8. Auxiliary Control Device: A device (such as a low voltage control transformer, electric relay, etc.) which is located in a control circuit and which carries or responds to (but does not initiate) an electrical control signal initiated by a control device.

- B. Work of Division-22 includes (but is not necessarily limited to):
1. Provide:
    - a. All controllers which are generally manufactured or shipped as integral with Division-22 equipment
    - b. All electric motors and other electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.) which are specified in Division 22.
    - c. All control circuits (including conduit and boxes) from the Division-26 panels to point of use including the necessary circuit breakers.
    - d. All other control circuits, including conduit and boxes.
    - e. All control connections to equipment.
    - f. All control connections to controllers, switches, motors and other plumbing systems electrical power consuming equipment (such as, electric boilers, electric hot water heaters, etc.).
    - g. Auxiliary control devices.
    - h. All control devices (thermostats, pressure switches, flow switches, humidistats, etc.) and make control circuit connections thereto.
    - i. Any and all pneumatic and electronic and electric control devices and electric or pneumatic connections thereto.
  2. Furnish:
    - a. All controllers which are generally manufactured and/or shipped as separate but companion items to Division-22 equipment.

1.10 AUXILIARIES AND ACCESSORIES

- A. Include all auxiliaries and accessories for complete and properly operating systems.

1.11 COORDINATION

- A. Provide all required coordination and supervision where work of this division connects to or is affected by work of others.

1.12 PROVISIONS FOR OPENINGS

- A. Provide all openings required for work performed under Division-22. Provide sleeves or other approved methods to allow passage of items installed under any Section of Division-22.

1.13 CLEANING AND PROTECTION

- A. Equipment: All plumbing equipment provided shall be thoroughly cleaned of all dirt, oil, concrete, etc. Any dents, scratches or other visible blemishes shall be corrected, and the appearance of the equipment made "like new" and to the satisfaction of the Architect/Engineer.
- B. Upon completion, and before final acceptance of the work, all debris, rubbish, leftover materials, tools and equipment shall be removed from the site.
- C. Protection of Work Until Final Acceptance: Protect all materials and equipment from damage, entrance of dirt and construction debris from the time of installation until final acceptance. Any materials and equipment which are damaged shall be repaired to "as new" condition or replaced at the direction of the Architect/Engineer. Where factory finishes occur and damage is minor, finishes may be touched up. If, in the opinion of the Architect/Engineer the damage is excessive, factory finish shall be replaced to "new" condition.

1.14 SHOP DRAWINGS

- A. Submit shop drawings for all items, services and systems included in the project.
- B. Shop drawings shall clearly show the following:
1. Technical and descriptive data in detail equal to or greater than the data given in the item specification. Indicate all characteristics, special modifications and features. Where performance and characteristic data is shown on the drawings or specified, submitted data shall be provided in a degree which is both quantitatively and qualitatively equal to that specified and shown so that comparison can be made. Present data in detail equal to or greater than that given in item specification and include all weights, deflections, speeds, velocities, pressure drops, operating temperatures, operating curves, temperature ranges, sound ratings, dimensions, sizes, manufacturers' names, model numbers, types of material used, operating pressures, full load amperages, starting amperages, fouling factors,

capacities, set points, chemical compositions, certifications and endorsements, operating voltages, thicknesses, gauges and all other related information as applicable to particular item.

2. Exceptions to or deviations from the contract documents. Should Architect/Engineer accept any items having such deviations which are not clearly brought to Architect/Engineer's attention, in writing, on item submittal, then Contractor is responsible for correction of such deviations regardless of when such deviations are discovered.

C. Additional Requirements: See specific sections of the Specifications for any additional requirements.

#### 1.15 SHOP DRAWINGS TECHNICAL INFORMATION SUBMITTALS

A. All submittals are to be submitted electronically in the form of PDF. Electronic submittal file names must be formatted with the specification section number followed by the title of the specification section. One PDF file shall be provided for each specification section that requires submittals to be provided.

B. A cover page shall have adequate space for Contractor, Subcontractor and Engineer review stamps and indicate the following minimum data:

1. Project Name
2. Project Address
3. Contractor Name
4. Subcontractor Name
5. Specification Section Number
6. Specification Section Name
7. Submittal Date

C. All shop drawings and equipment submittals shall be submitted complete based on specification division. Partial submittals of each specification section will not be accepted.

D. All submittals shall have been reviewed for compliance by the Contractor and associated subcontractor prior to submission to the Engineer. A stamp bearing the name of the reviewer and date review was completed shall be on the cover page of the submittal.

E. Submittal data shall be logically grouped based on equipment tags or like material. For submittals that contain data on multiple materials or equipment, it shall be clearly noted by equipment tag or applicable material.

F. Manufacturer's data indicating multiple options or choices shall be clearly noted as to what is applicable to the material and equipment being provided. Information not applicable should be struck through or extracted.

#### 1.16 SHOP DRAWINGS FOR PIPING SYSTEMS

A. Shop drawings for piping systems shall be performed by the installing subcontractors. Shop drawings shall show all required maintenance and operational clearances required. Title drawings shall include identification of project and names of Architect, Engineer, Contractor, subcontractor and/or supplier, date, be numbered sequentially and shall indicate the following:

1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
  - a. Fabrication and Erection dimensions.
  - b. Arrangements and sectional views.
  - c. Necessary details, including complete information for making connections with other work.
  - d. Kinds of materials and finishes.
  - e. Descriptive names of equipment.
  - f. Modifications and options to standard equipment required by the contract.

B. Shop drawings shall be submitted in electronic PDF format and shall bear the review stamp from the plumbing subcontractor and general contractor / CM that it has been reviewed for compliance.

C. See specific sections of specifications for further requirements.

1.17 ELECTRONIC FILES

- A. Any requests for electronic files shall be preceded by processing the required electronic file release form and submitting to the Engineer for authorization. Request for electronic files should be submitted through the Contractor for submission to the Architect / Engineer.

1.18 OPERATING INSTRUCTIONS

- A. Submit for checking a specific set of written operating instructions on each item which requires instructions to operate. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe operating instructions.

1.19 MAINTENANCE INFORMATION

- A. Submit for acceptance Maintenance Information consisting of manufacturer's printed instruction and parts lists for each major item of equipment. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe maintenance.

1.20 SYSTEM GUARANTEE

- A. The work required under Division-22 shall include a one-year guarantee. This guarantee shall be by the Contractor to the Owner to replace for the Owner any defective workmanship, equipment, or material which has been furnished under this Contract at no cost to the Owner for a period of one year from the date of acceptance of the System. This guarantee shall also include reasonable adjustments of the system required for proper operation during the guarantee period.

1.21 MATERIALS AND EQUIPMENT

- A. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.
  - 1. Submittal shall include the name of the material or equipment for which it is to be substituted, substituted equipment model numbers, drawings, cuts, performance and test data and any other data or information necessary for the Architect/Engineer to determine that the equipment meets all specification and requirements. If the Architect/Engineer accepts any proposed substitutions, such acceptance will be set forth in writing.
  - 2. Substituted equipment with all accessories installed or optional equipment where permitted and accepted, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at the Contractor's expense. Any modifications of related systems of this or other trades as a result of substitutions shall be made at the Contractor's expense, and Contractor shall so state in his written request for substitution.
- B. Acceptable Manufacturers: Materials and Equipment specified in these contract documents are accepted only in regard to general performance and quality. It shall be the Contractor's responsibility to ensure that acceptable materials and equipment meet or exceed the efficiencies, capacities, electrical characteristics, performance and quality of the equipment herein specified. Acceptable equipment must also generally conform, without extensive modification of related systems to the accessories, weights, space and maintenance requirements, etc., of the specified equipment. Any modification to related systems of this or other trades shall be made at the Contractor's expense and the Contractor shall be responsible for coordination between trades. Any difference in capacity, efficiency, electrical characteristics, weights or quality of product, etc., between specified materials and equipment and acceptable alternates shall be submitted to the Architect/Engineer for acceptance within 30 days of Notice to Proceed.

PART 2 - PRODUCTS

- 2.1 Section part not applicable.

PART 3 - EXECUTION

- 3.1 Section part not applicable.

END OF SECTION

**SECTION 22 05 23.12**

**BALL VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Brass ball valves.
  - 2. Bronze ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.5 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.
  - 1. Certification that products comply with NSF 61 and NSF 372.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and soldered ends.
  - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

**PART 2 - PRODUCTS**

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B1.20.1 for threads for threaded end valves.
  - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 3. ASME B16.18 for solder-joint connections.
  - 4. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
  - 2. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
  - 1. Include 2-inch stem extensions.
  - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
  - 3. Memory stops that are fully adjustable after insulation is applied.

## 2.2 BRASS BALL VALVES

- A. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Elkhart Products Corporation.
    - d. Jomar Valve.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. WATTS.
  - 2. Description:
    - a. Standard: MSS SP-110 or MSS SP-145.
    - b. CWP Rating: 600 psig.
    - c. Body Design: Two piece.
    - d. Body Material: Forged brass.
    - e. Ends: Threaded and soldered.
    - f. Seats: PTFE.
    - g. Stem: Brass.
    - h. Ball: Chrome-plated brass.
    - i. Port: Full.
- B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Press Ends:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Elkhart Products Corporation.
    - d. Hammond Valve.
    - e. Jomar Valve.
    - f. Legend Valve & Fitting, Inc.
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Stockham; Crane Energy Flow Solutions.
    - j. WATTS.
  - 2. Description:
    - a. Standard: MSS SP-110 or MSS SP-145.
    - b. CWP Rating: Minimum 200 psig.
    - c. Body Design: Two piece.
    - d. Body Material: Forged brass.
    - e. Ends: Press.
    - f. Press Ends Connections Rating: Minimum 200 psig.
    - g. Seats: PTFE or RPTFE.
    - h. Stem: Brass.

- i. Ball: Chrome-plated brass.
- j. Port: Full.
- k. O-Ring Seal: Buna-N or EPDM.

C. Brass Ball Valves, Two-Piece with Regular Port and Brass Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Flow Controls; Conbraco Industries, Inc.
  - b. Hammond Valve.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. WATTS.
- 2. Description:
  - a. Standard: MSS SP-110.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Forged brass.
  - e. Ends: Threaded and soldered.
  - f. Seats: PTFE.
  - g. Stem: Brass.
  - h. Ball: Chrome-plated brass.
  - i. Port: Regular.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Flow Controls; Conbraco Industries, Inc.
  - b. Crane; Crane Energy Flow Solutions.
  - c. FNW; Ferguson Enterprises, Inc.
  - d. Milwaukee Valve Company.
  - e. NIBCO INC.
  - f. WATTS.
  - g. Zurn Industries, LLC.
- 2. Description:
  - a. Standard: MSS SP-110 or MSS-145.
  - b. CWP Rating: 600 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Bronze.
  - e. Ends: Threaded and soldered.
  - f. Seats: PTFE.
  - g. Stem: Bronze or brass.
  - h. Ball: Chrome-plated brass.
  - i. Port: Full.

B. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Press Ends:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Flow Controls; Conbraco Industries, Inc.
  - b. Crane; Crane Energy Flow Solutions.
  - c. Milwaukee Valve Company.
  - d. NIBCO INC.
  - e. WATTS.
  - f. Zurn Industries, LLC.
- 2. Description:
  - a. Standard: MSS SP-110 or MSS-145.
  - b. CWP Rating: Minimum 200 psig.
  - c. Body Design: Two piece.
  - d. Body Material: Bronze.
  - e. Ends: Press.

- f. Press Ends Connections Rating: Minimum 200 psig.
  - g. Seats: PTFE or RTPFE.
  - h. Stem: Bronze or brass.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.
  - k. O-Ring Seal: EPDM or Buna-N.
- C. Bronze Ball Valves, Two-Piece with Regular Port and Bronze or Brass Trim:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Milwaukee Valve Company.
    - c. NIBCO INC.
    - d. WATTS.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. CWP Rating: 600 psig.
    - c. Body Design: Two piece.
    - d. Body Material: Bronze.
    - e. Ends: Threaded.
    - f. Seats: PTFE.
    - g. Stem: Bronze or brass.
    - h. Ball: Chrome-plated brass.
    - i. Port: Regular.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Install valves and cocks in horizontal piping with the valve stem in the vertical upright position.
- G. Install valves and cocks to provide adequate clearance to permit easy operation of the valve hand wheel and permit servicing of the valve packing.

#### **3.2 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.



3.3 ACCESS PANELS

- A. Furnish adequate number of properly sized access panels to adequately service and maintain systems installed under each section of specifications.
- B. Access panels shall be installed and painted under other divisions of these specifications. Exact panel location shall be designated by the subcontractor performing the work of this Section.
- C. Access panels are not required in exposed grid or other types of readily removable ceilings.
- D. Access panels shall not compromise the fire rating of the wall.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Brass ball valve, one piece. Provide with threaded or solder-joint ends.
  - 2. Bronze ball valve, one piece with bronze trim. Provide with threaded or solder-joint ends.
  - 3. Brass ball valves, two-piece with full port and brass trim. Provide with threaded or solder joint ends.
  - 4. Bronze ball valves, two-piece with full port and bronze or brass trim. Provide with threaded or solder-joint ends.
  - 5. Brass ball valves, three-piece with full port and brass trim.
  - 6. Bronze ball valves, three-piece with full port and bronze or brass trim.
  - 7. Bronze ball valves, two-piece with regular port and bronze trim.
- B. Pipe NPS 2-1/2 and Larger:
  - 1. Steel and Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
  - 2. Steel ball valves, Class 150 with full port.
  - 3. Iron ball valves, Class 150.

END OF SECTION

**SECTION 22 05 23.14**

**CHECK VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Bronze lift check valves.
  - 2. Bronze swing check valves.
  - 3. Bronze swing check valves, press ends.
  - 4. Iron swing check valves.
  - 5. Iron swing check valves with closure control.
  - 6. Iron, grooved-end swing check valves.
  - 7. Iron, center-guided check valves.
  - 8. Iron, plate-type check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.5 ACTION SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.
- B. Product Data: For each type of valve:
  - 1. Certification that products comply with NSF 61 and NSF 372.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS FOR VALVES**

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B1.20.1 for threads for threaded end valves.
  - 2. ASME B16.1 for flanges on iron valves.
  - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 4. ASME B16.18 for solder joint.
  - 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.

**2.2 BRONZE LIFT CHECK VALVES**

- A. Bronze Lift Check Valves with Bronze Disc, Class 125:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane; Crane Energy Flow Solutions.
    - b. Jenkins Valves; Crane Energy Flow Solutions.
    - c. Stockham; Crane Energy Flow Solutions.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 1.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Vertical flow.
    - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
    - e. Ends: Threaded or soldered. See valve schedule articles.
    - f. Disc: Bronze.

**2.3 BRONZE SWING CHECK VALVES**

- A. Bronze Swing Check Valves with Bronze Disc, Class 125:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Jenkins Valves; Crane Energy Flow Solutions.
    - d. NIBCO INC.
    - e. Stockham; Crane Energy Flow Solutions.
    - f. WATTS.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded or soldered. See valve schedule articles.
    - f. Disc: Bronze.

- B. Bronze Swing Check Valves with Bronze Disc, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Jenkins Valves; Crane Energy Flow Solutions.
    - d. Jomar Valve.
    - e. NIBCO INC.
    - f. Stockham; Crane Energy Flow Solutions.
  2. Description:
    - a. Standard: MSS SP-80, Type 3.
    - b. CWP Rating: 300 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded or soldered. See valve schedule articles.
    - f. Disc: Bronze.
- C. Bronze Swing Check Valves, Press Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Elkhart Products Corporation.
    - c. Milwaukee Valve Company.
    - d. NIBCO INC.
  2. Description:
    - a. Standard: MSS SP-80 and MSS SP-139.
    - b. CWP Rating: Minimum 200 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 584, bronze.
    - e. Ends: Press.
    - f. Press Ends Connection Rating: Minimum 200 psig
    - g. Disc: Brass or bronze.

#### 2.4 IRON SWING CHECK VALVES

- A. Iron Swing Check Valves with Metal Seats, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Jenkins Valves; Crane Energy Flow Solutions.
    - d. NIBCO INC.
    - e. Powell Valves.
    - f. Red-White Valve Corp.
    - g. Stockham; Crane Energy Flow Solutions.
    - h. Sure Flow Equipment Inc.
    - i. WATTS.
  2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Clear or full waterway.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged or threaded. See valve schedule articles.
    - f. Trim: Bronze.
    - g. Gasket: Asbestos free.
- B. Iron Swing Check Valves with Metal Seats, Class 250:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Jenkins Valves; Crane Energy Flow Solutions.
    - d. NIBCO INC.
    - e. Stockham; Crane Energy Flow Solutions.

f. WATTS.

2. Description:
  - a. Standard: MSS SP-71, Type I.
  - b. CWP Rating: 500 psig.
  - c. Body Design: Clear or full waterway.
  - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - e. Ends: Flanged or threaded. See valve schedule articles.
  - f. Trim: Bronze.
  - g. Gasket: Asbestos free.

## 2.5 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane; Crane Energy Flow Solutions.
    - b. Jenkins Valves; Crane Energy Flow Solutions.
    - c. NIBCO INC.
    - d. Stockham; Crane Energy Flow Solutions.
    - e. WATTS.
  2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Clear or full waterway.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged or threaded. See valve schedule articles.
    - f. Trim: Bronze.
    - g. Gasket: Asbestos free.
    - h. Closure Control: Factory-installed exterior lever and weight.
- B. Iron Swing Check Valves with Lever and Weight-Closure Control, Class 125:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Jenkins Valves; Crane Energy Flow Solutions.
    - d. NIBCO INC.
    - e. Stockham; Crane Energy Flow Solutions.
    - f. WATTS.
  2. Description:
    - a. Standard: MSS SP-71, Type I.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Clear or full waterway.
    - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
    - e. Ends: Flanged or threaded. See valve schedule articles.
    - f. Trim: Bronze.
    - g. Gasket: Asbestos free.
    - h. Closure Control: Factory-installed exterior lever and weight.

## 2.6 IRON, GROOVED-END SWING CHECK VALVES

- A. Iron, Grooved-End Swing Check Valves, 300 CWP:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. Shurjoint Piping Products USA Inc.
    - c. Tyco Fire Products LP.
    - d. Victaulic Company.
  2. Description:
    - a. CWP Rating: 300 psig.
    - b. Body Material: ASTM A 536, ductile iron.
    - c. Seal: EPDM.

- d. Disc: Spring operated, ductile iron or stainless steel.

## 2.7 IRON, CENTER-GUIDED, SPRING-LOADED CHECK VALVES

- A. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 125:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. APCO Willamette Valve and Primer Corporation.
    - c. Crispin Valve.
    - d. DFT Inc.
    - e. Flo Fab Inc.
    - f. FNW; Ferguson Enterprises, Inc.
    - g. Milwaukee Valve Company.
    - h. Mueller Steam Specialty; A WATTS Brand.
    - i. NIBCO INC.
    - j. Val-Matic Valve & Manufacturing Corp.
    - k. WATTS.
  - 2. Description:
    - a. Standard: MSS SP-125.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM A 126, gray iron.
    - d. Style: Compact wafer, spring loaded.
    - e. Seat: Bronze.
- B. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 125:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Crispin Valve.
    - c. DFT Inc.
    - d. Flomatic Corporation.
    - e. Milwaukee Valve Company.
    - f. Mueller Steam Specialty; A WATTS Brand.
    - g. NIBCO INC.
    - h. Sure Flow Equipment Inc.
    - i. Val-Matic Valve & Manufacturing Corp.
    - j. WATTS.
  - 2. Description:
    - a. Standard: MSS SP-125.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM A 126, gray iron.
    - d. Style: Globe, spring loaded.
    - e. Ends: Flanged.
    - f. Seat: Bronze.
- C. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 150:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Crispin Valve.
    - c. Val-Matic Valve & Manufacturing Corp.
  - 2. Description:
    - a. Standard: MSS SP-125.
    - b. CWP Rating: 300 psig.
    - c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
    - d. Style: Globe, spring loaded.
    - e. Ends: Flanged.
    - f. Seat: Bronze.
- D. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 250:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.

- b. Flomatic Corporation.
- c. Metraflex Company (The).
- d. Mueller Steam Specialty; A WATTS Brand.
- e. NIBCO INC.

2. Description:

- a. Standard: MSS SP-125.
- b. CWP Rating: 400 psig.
- c. Body Material: ASTM A 126, gray iron.
- d. Style: Globe, spring loaded.
- e. Ends: Flanged.
- f. Seat: Bronze.

E. Iron Globe, Center-Guided Check Valves with Metal Seat, Class 300:

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

- a. APCO Willamette Valve and Primer Corporation.
- b. Crispin Valve.
- c. Val-Matic Valve & Manufacturing Corp.

2. Description:

- a. Standard: MSS SP-125.
- b. CWP Rating: 500 psig.
- c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
- d. Style: Globe, spring loaded.
- e. Ends: Flanged.
- f. Seat: Bronze.

F. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 125:

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

- a. APCO Willamette Valve and Primer Corporation.
- b. Apollo Flow Controls; Conbraco Industries, Inc.
- c. NIBCO INC.
- d. Sure Flow Equipment Inc.
- e. Val-Matic Valve & Manufacturing Corp.
- f. Zurn Industries, LLC.

2. Description:

- a. Standard: MSS SP-125.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron.
- d. Style: Globe, spring loaded.
- e. Ends: Flanged.
- f. Seat: NBR.

G. Iron Globe, Center-Guided Check Valves with Resilient Seat, Class 300:

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

- a. APCO Willamette Valve and Primer Corporation.
- b. Val-Matic Valve & Manufacturing Corp.

2. Description:

- a. Standard: MSS SP-125.
- b. CWP Rating: 500 psig.
- c. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
- d. Style: Globe, spring loaded.
- e. Ends: Flanged.
- f. Seat: NBR.

## 2.8 IRON, PLATE-TYPE CHECK VALVES

A. Iron, Dual-Plate Check Valves with Metal Seat, Class 125:

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

- a. APCO Willamette Valve and Primer Corporation.
- b. Crane; Crane Energy Flow Solutions.

- c. Powell
  - d. Mueller Steam Specialty; A WATTS Brand.
2. Standard: API 594.
  3. CWP Rating: 200 psig.
  4. Body Design: Wafer, spring-loaded plates.
  5. Body Material: ASTM A 126, gray iron.
  6. Seat: Bronze.
- B. Iron, Dual-Plate Check Valves with Metal Seat, Class 150:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Mueller Steam Specialty; A WATTS Brand.
    - d. Val-Matic Valve & Manufacturing Corp.
  2. Standard: API 594.
  3. CWP Rating: 300 psig.
  4. Body Design: Wafer, spring-loaded plates.
  5. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
  6. Seat: Bronze.
- C. Iron, Dual-Plate Check Valves with Metal Seat, Class 250:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Crane; Crane Energy Flow Solutions.
  2. Standard: API 594.
  3. CWP Rating: 400 psig.
  4. Body Design: Wafer, spring-loaded plates.
  5. Body Material: ASTM A 126, gray iron.
  6. Seat: Bronze.
- D. Iron, Dual-Plate Check Valves with Metal Seat, Class 300:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Mueller Steam Specialty; A WATTS Brand.
    - d. Val-Matic Valve & Manufacturing Corp.
  2. Standard: API 594.
  3. CWP Rating: 500 psig.
  4. Body Design: Wafer, spring-loaded plates.
  5. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
  6. Seat: Bronze.
- E. Iron, Single-Plate Check Valves with Resilient Seat, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Flo Fab Inc.
    - b. Keckley Company.
    - c. Sure Flow Equipment Inc.
  2. Standard: API 594.
  3. CWP Rating: 200 psig.
  4. Body Design: Wafer, spring-loaded plate.
  5. Body Material: ASTM A 126, gray iron.
- F. Iron, Dual-Plate Check Valves with Resilient Seat, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Cooper Cameron Valves.
    - c. Crane; Crane Energy Flow Solutions.
    - d. NIBCO INC.



- e. Spence Strainers International.
  - f. Sure Flow Equipment Inc.
  - g. WATTS.
- 2. Standard: API 594.
  - 3. CWP Rating: 200 psig.
  - 4. Body Design: Wafer, spring-loaded plates.
  - 5. Body Material: ASTM A 126, gray iron.
  - 6. Seat: NBR.
- G. Iron, Dual-Plate Check Valves with Resilient Seat, Class 150:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Val-Matic Valve & Manufacturing Corp.
  - 2. Standard: API 594.
  - 3. CWP Rating: 300 psig.
  - 4. Body Design: Wafer, spring-loaded plates.
  - 5. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
  - 6. Seat: NBR.
- H. Iron, Wafer, Single-Plate Check Valves with Resilient Seat, Class 250:
- 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Sure Flow Equipment Inc.
  - 2. Standard: API 594.
  - 3. CWP Rating: 400 psig.
  - 4. Body Design: Wafer, spring-loaded plate.
  - 5. Body Material: ASTM A 126, gray iron.
  - 6. Seat: NBR.
- I. Iron, Dual-Plate Check Valves with Resilient Seat, Class 250:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Crane; Crane Energy Flow Solutions.
    - c. Sure Flow Equipment Inc.
  - 2. Standard: API 594.
  - 3. CWP Rating: 400 psig.
  - 4. Body Design: Wafer, spring-loaded plates.
  - 5. Body Material: ASTM A 126, gray iron.
  - 6. Seat: NBR.
- J. Iron, Dual-Plate Check Valves with Resilient Seat, Class 300:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Val-Matic Valve & Manufacturing Corp.
  - 2. Standard: API 594.
  - 3. CWP Rating: 500 psig.
  - 4. Body Design: Wafer, spring-loaded plates.
  - 5. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
  - 6. Seat: NBR.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Check Valves: Install check valves for proper direction of flow.
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Check Valves: In horizontal or vertical position, between flanges.
  - 3. Lift Check Valves: With stem upright and plumb.
- F. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

### 3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 ACCESS PANELS

- A. Furnish adequate number of properly sized access panels to adequately service and maintain systems installed under each section of specifications.
- B. Access panels shall be installed and painted under other divisions of these specifications. Exact panel location shall be designated by the subcontractor performing the work of this Section.
- C. Access panels are not required in exposed grid or other types of readily removable ceilings.
- D. Access panels shall not compromise the fire rating of the wall.

### 3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
  - 1. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
    - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided check valves.
    - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.

2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.
3. For Copper Tubing, NPS 5 and Larger: Flanged.
4. For Steel Piping, NPS 2 and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged or threaded.
6. For Steel Piping, NPS 5 and Larger: Flanged.
7. For Grooved-End Copper Tubing: Grooved.

### 3.6 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  1. Bronze swing check valves with bronze disc, with soldered end connections.
  2. Bronze swing check valves with press-end connections.
  
- B. Pipe NPS 2-1/2 and Larger:
  1. Iron swing check valves with metal seats, with threaded or flanged end connections.
  2. Iron swing check valves with closure control lever, Class 125, with threaded or flanged end connections.
  3. Iron, grooved-end swing check valves, 300 CWP.
  4. Iron, center-guided check valves with compact wafer, Class 125.
  5. Iron, center-guided check valves with metal or resilient seat, with threaded or flanged end connections.
  6. Iron, dual-plate check valves with metal seat, with threaded or flanged end connections.
  7. Iron, single-plate check valves with resilient seat, with threaded or flanged end connections.

**END OF SECTION**

**SECTION 22 05 29**

**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Fastener systems.
  - 5. Pipe stands.
  - 6. Equipment supports.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Submit manufacturer's data for review before any work is commenced
- B. Fabrication and installation details and include calculations for the following:
  - 1. Trapeze pipe hangers.
  - 2. Metal framing systems.
  - 3. Fiberglass strut systems.
  - 4. Pipe stands.
  - 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail fabrication and assembly of trapeze hangers.
  - 2. Include design calculations for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

## 2.2 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
  - 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer
- B. Stainless-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe and Tube Hangers:
  - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer.

## 2.3 TRAPEZE PIPE HANGERS

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

## 2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. B-line, an Eaton business.
    - b. Flex-Strut Inc.
    - c. G-Strut.
    - d. Haydon Corporation.
    - e. Thomas & Betts Corporation; A Member of the ABB Group.
    - f. Unistrut; Part of Atkore International.
    - g. Wesanco, Inc.
  - 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
  - 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 4. Channels: Continuous slotted channel with inturned lips.
  - 5. Channel Width: Selected for applicable load criteria.
  - 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  - 7. Hanger Rods: Continuous-thread rod, nuts, and washer
- B. Non-MFMA Manufacturer Metal Framing Systems:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. Carpenter & Paterson, Inc.
    - c. Empire Industries, Inc.
    - d. FNW; Ferguson Enterprises, Inc.
    - e. MIRO Industries.
    - f. PHD Manufacturing, Inc.

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

## 2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - c. MKT Fastening, LLC.
    - d. Simpson Strong-Tie Co., Inc.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. B-line, an Eaton business.
    - b. Empire Tool and Manufacturing Co., Inc.
    - c. Hilti, Inc.
    - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - e. MKT Fastening, LLC.
  2. Indoor Applications: Zinc-coated or stainless steel.
  3. Outdoor Applications: Stainless steel.

## 2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## 2.7 EQUIPMENT SUPPORTS

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

## 2.8 MATERIALS

- A. Aluminum: ASTM B 221.
- B. Carbon Steel: ASTM A 1011/A 1011M.
- C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A 240/A 240M.
- E. Grout: ASTM C 1107/C 1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  1. Properties: Nonstaining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi, 28-day compressive strength.

**PART 3 - EXECUTION**

3.1 APPLICATION

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. 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.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
  - 2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- F. Fastener System Installation:
  - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- G. Pipe Stand Installation:
  - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.
- H. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in

direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

- N. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- P. Insulated Piping:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    - b. NPS 4: 12 inches long and 0.06 inch thick.
    - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
  - 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
  - 6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

### 3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and/or equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.



3.5 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those 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 a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel attachments for general service applications.
- F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal hanger-shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
  - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

**SECTION 22 05 53**

**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
1. Equipment labels.
  2. Warning signs and labels.
  3. Pipe labels.

1.2 ACTION SUBMITTALS

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

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

**PART 2 - PRODUCTS**

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.
  - j. Seton Identification Products.
2. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: Yellow.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.

j. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: Yellow.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Carlton Industries, LP.
4. Champion America.
5. Craftmark Pipe Markers.
6. emedco.
7. LEM Products Inc.
8. Marking Sevcies Inc.
9. National Marker Company.
10. Seton Identification Products.
11. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: Black.

D. Background Color: Yellow.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  - 2. Brady Corporation.
  - 3. Brimar Industries, Inc.
  - 4. Carlton Industries, LP.
  - 5. Champion America.
  - 6. Craftmark Pipe Markers.
  - 7. emedco.
  - 8. Kolbi Pipe Marker Co.
  - 9. LEM Products Inc.
  - 10. Marking Services Inc.
  - 11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

## **PART 3 - EXECUTION**

### 3.1 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.2 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Architectural drawings and/or specifications.
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
  - 1. Low-Pressure Compressed Air Piping:
    - a. Background: Safety blue.
    - b. Letter Colors: White.
  - 2. High-Pressure Compressed Air Piping:
    - a. Background: Safety blue.
    - b. Letter Colors: White.

3. Domestic Water Piping
  - a. Background: Safety green.
  - b. Letter Colors: White.
  
4. Sanitary Waste and Storm Drainage Piping:
  - a. Background Color: Safety black.
  - b. Letter Color: White.

END OF SECTION

**SECTION 22 07 16**

**PLUMBING EQUIPMENT INSULATION**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing equipment:
  - 1. Domestic water heat exchangers.
  - 2. Domestic water converters.
  - 3. Domestic water, hot-water pumps.
  - 4. Domestic water storage tanks.

- B. Related Sections:
  - 1. Section 22 07 19 "Plumbing Piping Insulation."

1.3 ACTION SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.

1.4 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division-22 and to all other applicable portions of the Drawings and Specifications.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  - 1. Equipment Mockups: One tank or vessel.



2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

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

#### 1.8 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.
- C. Coordinate installation and testing of heat tracing.

#### 1.9 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### **PART 2 - PRODUCTS**

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Calcium Silicate:
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Industrial Insulation Group, LLC (IIG-LLC).
  2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
- G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Pittsburgh Corning Corporation.
  2. Block Insulation: ASTM C 552, Type I.

3. Special-Shaped Insulation: ASTM C 552, Type III.
  4. Board Insulation: ASTM C 552, Type IV.
  5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
  7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. K-Flex USA.
- I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.
- J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Industrial Insulation Group, LLC (IIG-LLC).
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. ROCKWOOL (ROXUL Inc.).
- K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.
- L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Industrial Insulation Group, LLC (IIG-LLC).
    - b. Knauf Insulation.
    - c. Rock Wool.
    - d. ROCKWOOL (ROXUL Inc.).
    - e. Thermafiber, Inc.; an Owens Corning company.
- M. Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. Knauf Insulation.
    - c. Manson Insulation Inc.
    - d. Owens Corning.
  2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- N. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or

with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. CertainTeed Corporation.
  - b. Johns Manville; a Berkshire Hathaway company.
  - c. Knauf Insulation.
  - d. Manson Insulation Inc.
  - e. Owens Corning.

O. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armacell LLC.
  - b. Nomaco Insulation.

## 2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Ramco Insulation, Inc.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Ramco Insulation, Inc.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Ramco Insulation, Inc.

## 2.3 ADHESIVES

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

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.
  - e. Vimasco Corporation.

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Foster Brand; H. B. Fuller Construction Products.

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Aeroflex USA, Inc.
  - b. Armacell LLC.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. K-Flex USA.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.

- F. Grade A for bonding insulation jacket lap seams and joints.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Dow Corning Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. P.I.C. Plastics, Inc.
    - d. Speedline Corporation.

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Knauf Insulation.
    - d. Vimasco Corporation.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
  - 3. Service Temperature Range: 0 to 180 deg F.
  - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
  - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
  - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
  - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  - 5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Knauf Insulation.
    - e. Mon-Eco Industries, Inc.
    - f. Vimasco Corporation.

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

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 26 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
    - c. Vimasco Corporation.
  3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
  4. Service Temperature Range: 0 to plus 180 deg F.
  5. Color: White.

## 2.6 SEALANTS

- A. Joint Sealants for Cellular-Glass Products:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
    - e. Pittsburgh Corning Corporation.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Permanently flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 100 to plus 300 deg F.
  5. Color: White or gray.
- B. FSK and Metal Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: Aluminum.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
  2. Materials shall be compatible with insulation materials, jackets, and substrates.
  3. Fire- and water-resistant, flexible, elastomeric sealant.
  4. Service Temperature Range: Minus 40 to plus 250 deg F.
  5. Color: White.

## 2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - 1) Dow Chemical Company (The).
5. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - 1) Dow Chemical Company (The).
6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
  - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - 1) Dow Chemical Company (The).

## 2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Foster Brand; H. B. Fuller Construction Products.
    - b. Vimasco Corporation.

## 2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Alpha Associates, Inc.

## 2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. P.I.C. Plastics, Inc.
    - c. Polyguard Products, Inc.
    - d. Proto Corporation.
    - e. Speedline Corporation.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: Color-code jackets based on system. Color as selected by Architect.
  4. Factory-fabricated tank heads and tank side panels.
- C. Metal Jacket:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.
    - b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Sheet and roll stock ready for shop or field sizing.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
  - a. Sheet and roll stock ready for shop or field sizing.
  - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

## 2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
    - e. Venture Tape.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company.
    - d. Knauf Insulation.
    - e. Venture Tape.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Compac Corporation.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - c. Venture Tape.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division.
- b. Compac Corporation.
- c. Ideal Tape Co., Inc., an American Biltrite Company.
- d. Knauf Insulation.
- e. Venture Tape.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Dow Chemical Company (The).
2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) Gemco.
    - 3) Midwest Fasteners, Inc.
    - 4) Nelson Stud Welding.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.
    - 2) CL WARD & Family Inc.
    - 3) Gemco.
    - 4) Midwest Fasteners, Inc.
    - 5) Nelson Stud Welding.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) AGM Industries, Inc.



- 2) Gemco.
  - 3) Midwest Fasteners, Inc.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Gemco.
      - 2) Midwest Fasteners, Inc.
    - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) AGM Industries, Inc.
      - 2) Gemco.
      - 3) Midwest Fasteners, Inc.
    - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    - c. Spindle: Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
    - d. Adhesive-backed base with a peel-off protective cover.
  6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) AGM Industries, Inc.
      - 2) Gemco.
      - 3) Midwest Fasteners, Inc.
      - 4) Nelson Stud Welding.
    - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
  7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Gemco.
      - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

- D. Wire: 0.062-inch soft-annealed, stainless steel.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. C & F Wire.

### 2.13 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 316.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.

- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. For above ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

### 3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
  - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
  - 3. Protect exposed corners with secured corner angles.
  - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    - a. Do not weld anchor pins to ASME-labeled pressure vessels.

- b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
  - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
  - d. Do not overcompress insulation during installation.
  - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
  - f. Impale insulation over anchor pins and attach speed washers.
  - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least 3 inches.
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
  2. Fabricate boxes from stainless steel, at least 0.060 inch thick.
  3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

- A. Insulation Installation on Domestic Water Boiler Breechings:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
  2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
  3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
  - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
  - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
  - 1. Draw jacket material smooth and tight.
  - 2. Install lap or joint strips with same material as jacket.
  - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
  - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
  - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
  - 1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
  - 2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

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

### 3.10 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment that is not factory insulated.
- C. Heat-exchanger (water-to-water for domestic water heating service) insulation shall be one of the following:
  - 1. Calcium Silicate: 3 inches thick.
  - 2. Cellular Glass: 3 inches thick.
  - 3. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 4. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 5. Mineral-Fiber Pipe and Tank: 2 inches thick.
  - 6. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.
- D. Steam-to-hot-water converter insulation shall be one of the following:
  - 1. Calcium Silicate: 3 inches thick.
  - 2. Cellular Glass: 3 inches thick.
  - 3. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 4. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 5. Mineral-Fiber Pipe and Tank: 2 inches thick.
  - 6. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.
- E. Domestic water pump insulation shall be one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
- F. Domestic chilled-water (potable) pump insulation shall be one of the following:
  - 1. Cellular Glass: 3 inches thick.
  - 2. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
- G. Domestic hot-water pump insulation shall be one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
- H. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:
  - 1. Cellular Glass: 1-1/2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 4. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 5. Mineral-Fiber Pipe and Tank: 1 inch thick.
  - 6. Polyolefin: 1 inch thick.
- I. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5:
  - 1. Cellular glass.
  - 2. Mineral-Fiber Blanket: 3-lb/cu. ft. nominal density.
  - 3. Mineral-Fiber Board: 3-lb/cu. ft. nominal density.
  - 4. Mineral-fiber pipe and tank.
- J. Domestic water storage tank insulation shall be one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 4. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 5. Mineral-Fiber Pipe and Tank: 1 inch thick.

6. Polyolefin: 1 inch thick.

K. Domestic chilled-water (potable) storage tank insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Blanket: 1 inch thick and 3-lb/cu. ft. nominal density.
4. Mineral-Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
5. Mineral-Fiber Pipe and Tank: 1 inch thick.
6. Polyolefin: 1 inch thick.

L. Domestic water filter-housing insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
4. Mineral-Fiber Pipe and Tank: 2 inches thick.

### 3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. PVC, Color-Coded by System: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.
4. Painted Aluminum, Smooth: 0.016 inch thick.
5. Stainless Steel, Type 316, Smooth 2B Finish: 0.016 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. None.
2. PVC, Color-Coded by System: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.
4. Painted Aluminum, Smooth: 0.016 inch thick.
5. Stainless Steel, Type 316, Smooth 2B Finish: 0.020 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. None.
2. Painted Aluminum, Smooth: 0.040 inch thick.
3. Stainless Steel, Type 316, Smooth: 0.024 inch thick.

### 3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. PVC, Color-Coded by System: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.
4. Painted Aluminum, Smooth: 0.016 inch thick.
5. Stainless Steel, Type 316, Smooth 2B Finish: 0.020 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Painted Aluminum, Smooth: 0.020 inch thick.
2. Stainless Steel, Type 316, Smooth 2B Finish: 0.020 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Painted Aluminum, Smooth: 0.040 inch thick.

2. Stainless Steel, Type 316, Smooth: 0.024 inch thick.

END OF SECTION



**SECTION 22 07 19**

**PLUMBING PIPING INSULATION**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Domestic recirculating hot-water piping.
  - 4. Domestic chilled-water piping for drinking fountains.
  - 5. Sanitary waste piping exposed to freezing conditions.
  - 6. Storm-water piping exposed to freezing conditions.
  - 7. Roof drains and rainwater leaders.
  - 8. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
  - 1. Section 22 07 16 "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.

1.4 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  - 1. Piping Mockups:
    - a. One 10-foot section of NPS 2 straight pipe.
    - b. One each of a 90-degree threaded, welded, and flanged elbow.
    - c. One each of a threaded, welded, and flanged tee fitting.
    - d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
    - e. Four support hangers including hanger shield and insert.
    - f. One threaded strainer and one flanged strainer with removable portion of insulation.
    - g. One threaded reducer and one welded reducer.
    - h. One pressure temperature tap.
    - i. One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

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

#### 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

### **PART 2 - PRODUCTS**

#### 2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Pittsburgh Corning Corporation.
  2. Block Insulation: ASTM C 552, Type I.

3. Special-Shaped Insulation: ASTM C 552, Type III.
  4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
  6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. K-Flex USA.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Manson Insulation Inc.
    - e. Owens Corning.
- I. Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. Knauf Insulation.
    - c. Manson Insulation Inc.
    - d. Owens Corning.
- J. Phenolic:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Kingspan Tarec Industrial Insulation NV.
    - b. Resolco International BV.
  2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
  3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
  4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
  5. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.
- K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armacell LLC.
    - b. Nomaco Insulation.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ramco Insulation, Inc.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ramco Insulation, Inc.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ramco Insulation, Inc.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Foster Brand; H. B. Fuller Construction Products.
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. K-Flex USA.
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
- E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Foster Brand; H. B. Fuller Construction Products.
- F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products.
    - d. Mon-Eco Industries, Inc.
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Dow Corning Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. P.I.C. Plastics, Inc.
    - d. Speedline Corporation.

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Foster Brand; H. B. Fuller Construction Products.
    - b. Knauf Insulation.
    - c. Vimasco Corporation.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Childers Brand; H. B. Fuller Construction Products.
- b. Eagle Bridges - Marathon Industries.
- c. Foster Brand; H. B. Fuller Construction Products.
- d. Mon-Eco Industries, Inc.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
3. Service Temperature Range: 0 to 180 deg F.
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Knauf Insulation.
  - e. Mon-Eco Industries, Inc.
  - f. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

## 2.5 LAGGING ADHESIVES

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

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Foster Brand; H. B. Fuller Construction Products.
  - c. Vimasco Corporation.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 0 to plus 180 deg F.
5. Color: White.

## 2.6 SEALANTS

A. Joint Sealants for Cellular-Glass and Phenolic Products:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.
  - e. Pittsburgh Corning Corporation.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.

4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

**B. FSK and Metal Jacket Flashing Sealants:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products.
  - d. Mon-Eco Industries, Inc.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

**C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:**

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

**2.7 FACTORY-APPLIED JACKETS**

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

**2.8 FIELD-APPLIED FABRIC-REINFORCING MESH**

**A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.**

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Childers Brand; H. B. Fuller Construction Products.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Foster Brand; H. B. Fuller Construction Products.
  - b. Vimasco Corporation.

**2.9 FIELD-APPLIED CLOTHS**

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

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. Alpha Associates, Inc.

**2.10 FIELD-APPLIED JACKETS**

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

**B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.**

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

- a. Johns Manville; a Berkshire Hathaway company.
  - b. P.I.C. Plastics, Inc.
  - c. Proto Corporation.
  - d. Speedline Corporation.
2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: Color as selected by Architect.
  4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products.
  - b. ITW Insulation Systems; Illinois Tool Works, Inc.
  - c. RPR Products, Inc.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Finish and thickness are indicated in field-applied jacket schedules.
  - b. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  - c. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  - d. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
  - a. Material, finish, and thickness are indicated in field-applied jacket schedules.
  - b. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
  - c. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
  - d. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Pittsburgh Corning Corporation.
  - b. Polyguard Products, Inc.

2.11 TAPES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.

- d. Knauf Insulation.
- e. Venture Tape.

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

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

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.
  - d. Knauf Insulation.
  - e. Venture Tape.
- 2. Width: 3 inches.
- 3. Thickness: 6.5 mils.
- 4. Adhesion: 90 ounces force/inch in width.
- 5. Elongation: 2 percent.
- 6. Tensile Strength: 40 lbf/inch in width.
- 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

**C. PVC Tape:** White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Compac Corporation.
  - b. Ideal Tape Co., Inc., an American Biltrite Company.
  - c. Venture Tape.
- 2. Width: 2 inches.
- 3. Thickness: 6 mils.
- 4. Adhesion: 64 ounces force/inch in width.
- 5. Elongation: 500 percent.
- 6. Tensile Strength: 18 lbf/inch in width.

**D. Aluminum-Foil Tape:** Vapor-retarder tape with acrylic adhesive.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.
  - d. Knauf Insulation.
  - e. Venture Tape.
- 2. Width: 2 inches.
- 3. Thickness: 3.7 mils.
- 4. Adhesion: 100 ounces force/inch in width.
- 5. Elongation: 5 percent.
- 6. Tensile Strength: 34 lbf/inch in width.

**2.12 SECUREMENTS**

**A. Bands:**

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ITW Insulation Systems; Illinois Tool Works, Inc.
  - b. RPR Products, Inc.
- 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 316; 0.015 inch thick, 1/2 inch] wide with wing seal.



3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
  - B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
  - C. Wire: 0.062-inch soft-annealed, stainless steel.
    1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      - a. C & F Wire.
- 2.13 PROTECTIVE SHIELDING GUARDS
- A. Protective Shielding Pipe Covers:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. Engineered Brass Company.
      - b. Insul-Tect Products Co.
      - c. McGuire Manufacturing.
      - d. Plumberex Specialty Products, Inc.
      - e. Truebro.
      - f. Zurn Industries, LLC.
    2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
  - B. Protective Shielding Piping Enclosures:
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - a. Truebro.
      - b. Zurn Industries, LLC.
    2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

### **PART 3 - EXECUTION**

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.

2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistant joint sealers.
- F. Insulation Installation at Floor Penetrations:
  1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

### 3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or

plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
  4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
  4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  - 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed sections of cellular-glass insulation to valve body.
  - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.

### 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  - 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install mitered sections of pipe insulation.
  - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.
  - 4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.8 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
  - 4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install preformed pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
  - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available.
  - 2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 4. Install insulation to flanges as specified for flange insulation application.

### 3.9 INSTALLATION OF PHENOLIC INSULATION

- A. General Installation Requirements:
  - 1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
  - 2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
- B. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
  - 4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- C. Insulation Installation on Pipe Flanges:
  - 1. Install preformed pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- E. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
  - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.

### 3.10 INSTALLATION OF POLYOLEFIN INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:
  - 1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.11 FIELD-APPLIED JACKET INSTALLATION

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

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

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

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

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

### 3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
  - a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

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

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

### 3.13 FIELD QUALITY CONTROL

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

- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  - 1. Drainage piping located in crawl spaces.
  - 2. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.15 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
  - 1. NPS 1 and Smaller: Insulation shall be one of the following:
    - a. Flexible Elastomeric: 1/2 inch thick.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
    - c. Phenolic: 1 inch thick.
    - d. Polyolefin: 1/2 inch thick.
  - 2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches thick.
    - b. Flexible Elastomeric: 1 inch thick.
    - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - d. Phenolic: 1 inch thick.
    - e. Polyolefin: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
  - 1. NPS 1-1/4 and Smaller: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches thick.
    - b. Flexible Elastomeric: 3/4 inch thick.
    - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - d. Phenolic: 1 inch thick.
    - e. Polyolefin: 1 inch thick.
  - 2. NPS 1-1/2 and Larger: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches thick.
    - b. Flexible Elastomeric: 1 inch thick.
    - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - d. Phenolic: 1 inch thick.
    - e. Polyolefin: 1 inch thick.
- C. Domestic Chilled Water (Potable):
  - 1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches thick.
    - b. Flexible Elastomeric: 1 inch thick.
    - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
    - d. Phenolic: 1 inch thick.
    - e. Polyolefin: 1 inch thick.



- D. Stormwater and Overflow:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 1-1/2 inches thick.
      - b. Flexible Elastomeric: 1 inch thick.
      - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
      - d. Phenolic: 1 inch thick.
      - e. Polyolefin: 1 inch thick.
  - E. Roof Drain and Overflow Drain Bodies:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 1-1/2 inches thick.
      - b. Flexible Elastomeric: 1 inch thick.
      - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
      - d. Phenolic: 1 inch thick.
      - e. Polyolefin: 1 inch thick.
  - F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Flexible Elastomeric: 3/4 inch thick.
      - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
      - c. Polyolefin: 1 inch thick.
  - G. Sanitary Waste Piping Where Heat Tracing Is Installed:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 2 inches thick.
      - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
      - c. Phenolic: 1-1/2 inches thick.
  - H. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 1-1/2 inches thick.
      - b. Flexible Elastomeric: 1 inch thick.
      - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
      - d. Phenolic: 1 inch thick.
      - e. Polyolefin: 1 inch thick.
  - I. Hot Service Drains:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 1-1/2 inches thick.
      - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.
  - J. Hot Service Vents:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 1-1/2 inches thick.
      - b. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.
- 3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE
- A. Domestic Water Piping:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 2 inches thick.
      - b. Flexible Elastomeric: 2 inches thick.
      - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
      - d. Phenolic: 2 inches thick.
      - e. Polyolefin: 2 inches thick.
  - B. Domestic Hot and Recirculated Hot Water:
    - 1. All Pipe Sizes: Insulation shall be one of the following:
      - a. Cellular Glass: 2 inches thick.
      - b. Flexible Elastomeric: 2 inches thick.
      - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

- d. Phenolic: 2 inches thick.
- e. Polyolefin: 2 inches thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

- 1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Cellular Glass: 2 inches thick.
  - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
  - c. Phenolic: 2 inches thick.

D. Hot Service Drains:

- 1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Cellular Glass: 1-1/2 inches thick.
  - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Hot Service Vents:

- 1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Cellular Glass: 1-1/2 inches thick.
  - b. Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch thick.

3.17 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches thick.
- B. Chilled Water, All Sizes: Cellular glass, 2 inches thick.

3.18 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
  - 2. PVC, Color-Coded by System: 30 mils thick.
  - 3. Aluminum, Smooth: 0.016 inch thick.
  - 4. Painted Aluminum, Smooth: 0.016 inch thick.
  - 5. Stainless Steel, Type 316, Smooth 2B Finish: 0.020 inch thick.
- D. Piping, Exposed:
  - 1. None.
  - 2. PVC, Color-Coded by System: 30 mils thick.
  - 3. Aluminum: 0.016 inch thick.
  - 4. Painted Aluminum, Smooth: 0.016 inch thick.
  - 5. Stainless Steel, Type 316: 0.020 inch thick.

3.19 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
  - 2. PVC, Color-Coded by System: 20 mils thick.
  - 3. Aluminum, Smooth: 0.016 inch thick.
  - 4. Painted Aluminum, Smooth: 0.016 inch thick.
  - 5. Stainless Steel, Type 316: 0.020 inch thick.
- D. Piping, Exposed:
  - 1. PVC: 20 mils thick.

2. Painted Aluminum, Smooth: 0.016 inch thick.
3. Stainless Steel, Type 316: 0.020 inch thick.

3.20 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

**SECTION 22 11 13**

**FACILITY WATER DISTRIBUTION PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies the water distribution piping system, including potable cold, hot, and recirculated hot water piping, fittings, and specialties within the building to a point 5 feet outside the building.

1.3 DEFINITIONS

- A. PE: Polyethylene plastic.
- B. PP: Polypropylene plastic.
- C. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Shop Drawing Data: For each type of product indicated.

1.5 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
  - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- E. Codes and Standards:
  - 1. ASTM A 120-84 Specifications for pipe.
  - 2. ASTM B 88-83A Specifications for seamless copper water tube.
  - 3. ANSI B16.4 Fittings, Flanges, and Valves.
  - 4. ANSI B16.22 Fittings, Flanges, and Valves.
  - 5. ASSE 1003 and 1003-1 - Performance Requirements for Water Pressure Reducing Valves.
  - 6. AWWA C110-82 Standard for Fittings, Flanges, and Valves.
  - 7. AWWA C600 - Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances.
  - 8. AWWA C110-82 Standard for Gaskets.
  - 9. AWWA C601 - Standard for Disinfecting Water Mains.
  - 10. PDI WH-201 - Water Hammer Arresters.
  - 11. Plumbing Code Compliance: Comply with applicable portions of BOCA Basic National Plumbing Code.

- F. ASME Compliance: Fabricate and stamp pressure - Standards of these Organizations, the more stringent regulations shall govern

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, according to the following:
  1. Ensure that valves are dry and internally protected against rust and corrosion.
  2. Protect valves against damage to threaded ends and flange faces.
  3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, and piping according to the following:
  1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
  2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
  3. Store pipe in a manner to prevent sagging and bending.
- C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- D. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- E. Protect flanges, fittings, and specialties from moisture and dirt.
- F. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

#### 1.8 SPARE PARTS

- A. Furnish to Owner, with receipt, one valve key for each key operated hydrant, bibb, or faucet installed.

#### 1.9 COORDINATION

- A. Coordinate connection to water main with utility company.

### **PART 2 - PRODUCTS**

#### 2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

#### 2.2 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
  1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
  1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- D. Copper Unions:
  1. MSS SP-123.
  2. Cast-copper-alloy, hexagonal-stock body.
  3. Ball-and-socket, metal-to-metal seating surfaces.
  4. Solder-joint or threaded ends.

- E. Copper, Brass or Bronze, Pressure-Seal-Joint Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Elkhart Products Corporation.
    - c. Mueller Industries, Inc.
    - d. NIBCO INC.
    - e. Viega LLC.
  - 2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
  - 3. Minimum 200-psig working-pressure rating at 250 deg F.

### 2.3 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
  - 1. Grooved-End, Ductile-Iron Pipe Appurtenances:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Anvil International.
      - 2) Smith-Cooper International.
      - 3) Victaulic Company.
    - b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
    - c. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Flanges: ASME 16.1, Class 125, cast iron.

### 2.4 PVC PIPE AND FITTINGS

- A. PVC, Schedule 40 Pipe: ASTM D 1785.
  - 1. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
- B. PVC, Schedule 80 Pipe: ASTM D 1785.
  - 1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
  - 2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
- C. PVC, AWWA Pipe: AWWA C900, with bell end with gasket, and with spigot end.
  - 1. Comply with UL 1285 for fire-service mains if indicated.
  - 2. PVC Fabricated Fittings: AWWA C900, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - 4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Gaskets: AWWA C111, rubber.
  - 5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

- a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

## 2.5 JOINING MATERIALS

- A. Copper Tubing: Solder joints in accordance with the procedures specified in ANSI B9.1
- B. Brazing Filler Metals: AWS A5.8, BCuP Series.
- C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

## 2.6 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Install backflow preventers at each connection to mechanical equipment and systems, and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Pipe relief outlet without valves, to nearest floor drain.
- C. Install pressure regulating valves with inlet and outlet shutoff valves, and balance cock bypass for domestic booster pump. Install pressure gage on valve outlet.

## 2.7 CORROSION-PROTECTION PIPING ENCASEMENT

- A. Encasement for Underground Metal Piping:
  - 1. Standards: ASTM A 674 or AWWA C105.
  - 2. Material: LLDPE film of 0.008-inch minimum thickness.
  - 3. Material: LLDPE film of 0.008-inch minimum thickness, or high-density, crosslaminated PE film of 0.004-inch minimum thickness.
  - 4. Material: High-density, crosslaminated PE film of 0.004-inch minimum thickness.

## 2.8 CHECK VALVES

- A. AWWA Check Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. APCO Willamette Valve and Primer Corporation.
    - b. Flomatic Corporation.
    - c. Mueller Co.
    - d. NIBCO INC.
    - e. Stockham; Crane Energy Flow Solutions.
    - f. WATTS.

## 2.9 BUTTERFLY VALVES

- A. AWWA Butterfly Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. DeZURIK/Copes-Vulcan.
    - b. Flomatic Corporation.
    - c. Milliken Valve Company.
    - d. Milwaukee Valve Company.
    - e. Mosser Valve.
    - f. Mueller Co.
    - g. Pratt, Henry Company.
    - h. Val-Matic Valve & Manufacturing Corp.

## 2.10 PLUG VALVES

- A. Plug Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. DeZURIK/Copes-Vulcan.

- b. Homestead Valve.
- c. M & H Valve Company; a division of McWane, Inc.
- d. Milliken Valve Company.
- e. Pratt, Henry Company.
- f. Val-Matic Valve & Manufacturing Corp.

- 2. Description: Resilient-seated eccentric.
  - a. Standard: MSS SP-108.
  - b. Body: Cast iron.
  - c. Pressure Rating: 175-psig minimum CWP.
  - d. Seat Material: Suitable for potable-water service.

B. Water meters will be furnished by utility company.

#### 2.11 VACUUM BREAKERS

A. Pressure Vacuum Breaker Assembly:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Fire & Waterworks; A WATTS Brand.
  - b. Apollo Flow Controls; Conbraco Industries, Inc.
  - c. FEBCO; A WATTS Brand.
  - d. Flowmatic Corporation.
  - e. Toro Company (The).
  - f. WATTS.
  - g. Wilkins.
  - h. Zurn Industries, LLC.
- 2. Standard: ASSE 1020.
- 3. Accessories: Ball valves on inlet and outlet.

### **PART 3 - EXECUTION**

#### 3.1 PIPING SCHEDULE

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 3/4 to NPS 3 shall be any of the following:
  - 1. Soft copper tube, ASTM B 88, Type K.
  - 2. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
- F. Underground water-service piping NPS 4 to NPS 8 shall be any of the following:
  - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
  - 2. Ductile-iron, piping and joints.
  - 3. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented joints.
- G. Aboveground Water-Service Piping NPS 3/4 to NPS 3 shall be any of the following:
  - 1. Hard copper tube, ASTM B 88, Type K.
  - 2. PVC, Schedule 80 pipe.
- H. Aboveground water-service piping NPS 4 to NPS 8 shall be any of the following:
  - 1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
  - 2. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
  - 3. PVC, Schedule 80 pipe.



### 3.2 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Underground Valves, NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, gate valves with valve box.
  - 2. Underground Valves, NPS 4 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
  - 3. Pressure-Reducing Valves: Use for water-service piping aboveground to control water pressure.
  - 4. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

### 3.3 PIPING INSTALLATION

- A. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- B. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- C. Bury piping with depth of cover over top at least 30 inches with top at least 12 inches level of maximum frost penetration, and according to the following:
  - 1. Under Driveways: With at least 36 inches cover over top.
  - 2. Under Railroad Tracks: With at least 48 inches cover over top.
  - 3. In Loose Gravelly Soil and Rock: With at least 12 inches additional cover.
- D. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- E. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- F. See Section 22 11 16 "Domestic Water Piping" for potable-water piping inside the building.

### 3.4 JOINT CONSTRUCTION

- A. Make pipe joints according to the following:
  - 1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
  - 2. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
  - 3. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
  - 4. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
  - 5. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
  - 6. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

### 3.5 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
  - 1. Concrete thrust blocks.
  - 2. Locking mechanical joints.
  - 3. Set-screw mechanical retainer glands.
  - 4. Bolted flanged joints.
  - 5. Heat-fused joints.
  - 6. Pipe clamps and tie rods.

- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
  - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.6 VALVE INSTALLATION

- A. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- B. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
- C. MSS Valves: Install as component of connected piping system.
- D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

### 3.7 VACUUM BREAKER ASSEMBLY INSTALLATION

- A. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.

### 3.8 EQUIPMENT CONNECTIONS

- A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by Plumbing Code.
- B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide connection. For connections 2-1/2" and larger, use flanges instead of unions.

### 3.9 FIELD QUALITY CONTROL

- A. Inspections:
  - 1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.
  - 2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform test specified below in the presence of the plumbing official.
    - a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.
    - b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing official.
    - c. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange System Test:
  - 3. Test for leaks and defects all new water distribution piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.
  - 4. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
  - 5. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for a period of 4 hours. Leaks and loss in test pressure constitute defects which must be repaired.
  - 6. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

3.10 ADJUSTING AND CLEANING

A. Cleaning and Disinfecting:

1. Purge all new water distribution piping systems and parts of existing systems, which have been altered, extended, or repaired prior to use.
2. Use the purging and disinfecting procedure prescribed by the authority having jurisdiction, or in case a method is not prescribed by that authority, the procedure described in either AWWA C601, or AWWA D105, or as described below:
  - a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.
  - b. Fill the system or part thereof, with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system, or part thereof, and allow to stand for 24 hours.
  - c. Drain the system, or part thereof, of the previous solution, and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.
  - d. Following the allowed standing time, flush the system with clean potable water until chlorine does not remain in the water coming for the system.
  - e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

END OF SECTION

**SECTION 22 11 16**

**DOMESTIC WATER PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Galvanized steel pipe and fittings.
4. Stainless-steel piping
5. CPVC piping.
6. PEX tube and fittings.
7. PVC pipe and fittings.
8. Piping joining materials.
9. Encasement for piping.
10. Transition fittings.
11. Dielectric fittings.

B. Related Requirements:

1. Section 22 11 13 "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.
2. Alternates may or may not substantially change scope and general character of the work; and must not be confused with "change orders", "substitutions", and other similar provisions.
3. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.3 ACTION SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.

**PART 2 - PRODUCTS**

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
  1. MSS SP-123.

2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Flow Controls; Conbraco Industries, Inc.
  - b. Elkhart Products Corporation.
  - c. Mueller Industries, Inc.
  - d. NIBCO INC.
  - e. Viega LLC.
2. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
3. Minimum 200-psig working-pressure rating at 250 deg F.

H. Copper Push-on-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Apollo Flow Controls; Conbraco Industries, Inc.
  - b. Elkhart Products Corporation.
  - c. NIBCO INC.
  - d. Victaulic Company.
2. Description:
  - a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
  - b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

I. Copper-Tube, Extruded-Tee Connections:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - a. T-DRILL Industries Inc.
2. Description: Tee formed in copper tube according to ASTM F 2014.

J. Appurtenances for Grooved-End Copper Tubing:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Anvil International.
  - b. Grinnell Mechanical Products.
  - c. Shurjoint Piping Products USA Inc.
  - d. Victaulic Company.
2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
3. Mechanical Couplings for Grooved-End Copper Tubing:
  - a. Copper-tube dimensions and design similar to AWWA C606.
  - b. Ferrous housing sections.
  - c. EPDM-rubber gaskets suitable for hot and cold water.
  - d. Bolts and nuts.
  - e. Minimum Pressure Rating: 300 psig.

### 2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

- C. Compact-Pattern, Mechanical-Joint Fittings:
  - 1. AWWA C153/A21.53, ductile iron.
  - 2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- D. Push-on-Joint, Ductile-Iron Pipe:
  - 1. AWWA C151/A21.51.
  - 2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
- E. Standard-Pattern, Push-on-Joint Fittings:
  - 1. AWWA C110/A21.10, ductile or gray iron.
  - 2. Gaskets: AWWA C111/A21.11, rubber.
- F. Compact-Pattern, Push-on-Joint Fittings:
  - 1. AWWA C153/A21.53, ductile iron.
  - 2. Gaskets: AWWA C111/A21.11, rubber.
- G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.
- H. Appurtenances for Grooved-End, Ductile-Iron Pipe:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Shurjoint Piping Products USA Inc.
    - b. Smith-Cooper International.
    - c. Star Pipe Products.
    - d. Victaulic Company.
  - 2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
  - 3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
    - a. AWWA C606 for ductile-iron-pipe dimensions.
    - b. Ferrous housing sections.
    - c. EPDM-rubber gaskets suitable for hot and cold water.
    - d. Bolts and nuts.

#### 2.4 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe:
  - 1. ASTM A 53/A 53M, Standard Weight.
  - 2. Include ends matching joining method.
- B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
- C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable-Iron Unions:
  - 1. ASME B16.39, Class 150.
  - 2. Hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal, bronze seating surface.
  - 4. Threaded ends.
- E. Flanges: ASME B16.1, Class 125, cast iron.
- F. Appurtenances for Grooved-End, Galvanized-Steel Pipe:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. Grinnell Mechanical Products.
    - c. Shurjoint Piping Products USA Inc.
    - d. Victaulic Company.
  - 2. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

3. Fittings for Grooved-End, Galvanized-Steel Pipe:
  - a. AWWA C606 for steel-pipe dimensions.
  - b. Ferrous housing sections.
  - c. EPDM-rubber gaskets suitable for hot and cold water.
  - d. Bolts and nuts.

## 2.5 STAINLESS-STEEL PIPING

- A. Potable-water piping and components shall comply with NSF 61 Annex G.
- B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 40.
- C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.
- D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. Grinnell Mechanical Products.
    - c. Shurjoint Piping Products USA Inc.
    - d. Victaulic Company.
  2. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
  3. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:
    - a. AWWA C606 for stainless-steel-pipe dimensions.
    - b. Stainless-steel housing sections.
    - c. Stainless-steel bolts and nuts.
    - d. EPDM-rubber gaskets suitable for hot and cold water.

## 2.6 CPVC PIPING

- A. CPVC Pipe: ASTM F 441/F 441M, Schedule 80.
  1. CPVC Socket Fittings: ASTM F 439 for Schedule 80.
  2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
- B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.
- C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

## 2.7 PEX TUBE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. IPEX USA LLC.
  2. Uponor.
  3. Viega LLC.
  4. Watts Radiant; A WATTS Brand.
  5. Zurn Industries, LLC.
- B. Tube Material: PEX plastic according to ASTM F 876.
- C. Fittings: ASSE 1061, push-fit fittings.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Zurn Industries, LLC.
    - b. Uponor.
- D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 876; with plastic or corrosion-resistant-metal valve for each outlet.

## 2.8 PVC PIPE AND FITTINGS

- A. PVC Pipe: ASTM D 1785, Schedule 80.

B. PVC Socket Fittings: ASTM D 2467 for Schedule 80.

C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

## 2.9 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

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

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.10 ENCASUREMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

## 2.11 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cascade Waterworks Mfg. Co.
  - b. Dresser, Inc.
  - c. Ford Meter Box Company, Inc. (The).
  - d. Jay R. Smith Mfg. Co.
  - e. JCM Industries, Inc.
  - f. Romac Industries, Inc.
  - g. Smith-Blair, Inc.
  - h. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Charlotte Pipe and Foundry Company.
  - b. Harvel Plastics, Inc.
  - c. Spears Manufacturing Company.
  - d. Uponor.
2. Description:
  - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
  - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.



- E. Plastic-to-Metal Transition Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Colonial Engineering, Inc.
    - b. NIBCO INC.
    - c. Spears Manufacturing Company.
  - 2. Description:
    - a. CPVC or PVC four-part union.
    - b. Brass or stainless-steel threaded end.
    - c. Solvent-cement-joint or threaded plastic end.
    - d. Rubber O-ring.
    - e. Union nut.

## 2.12 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. A.Y. McDonald Mfg. Co.
    - b. Capitol Manufacturing Company.
    - c. Central Plastics Company.
    - d. HART Industrial Unions, LLC.
    - e. Jomar Valve.
    - f. Matco-Norca.
    - g. WATTS.
    - h. Wilkins.
    - i. Zurn Industries, LLC.
  - 2. Standard: ASSE 1079.
  - 3. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Matco-Norca.
    - d. WATTS.
    - e. Wilkins.
    - f. Zurn Industries, LLC.
  - 2. Standard: ASSE 1079.
  - 3. Factory-fabricated, bolted, companion-flange assembly.
  - 4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Nonconducting materials for field assembly of companion flanges.
  - 3. Gasket: Neoprene or phenolic.
  - 4. Bolt Sleeves: Phenolic or polyethylene.
  - 5. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Elster Perfection Corporation.
    - b. Grinnell Mechanical Products.

- c. Matco-Norca.
  - d. Precision Plumbing Products.
  - e. Victaulic Company.
- 2. Standard: IAPMO PS 66.
  - 3. Electroplated steel nipple complying with ASTM F 1545.
  - 4. End Connections: Male threaded or grooved.
  - 5. Lining: Inert and noncorrosive, propylene.

### **PART 3 - EXECUTION**

#### **3.1 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install water-pressure-reducing valves downstream from shutoff valves.
- H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- I. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- K. Install piping to permit valve servicing.
- L. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install PEX tubing with loop at each change of direction of more than 90 degrees.
- P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump and provide booster pump by-pass.
- R. Install thermostats in hot-water circulation piping.
- S. Install thermometers on inlet and outlet piping from each water heater.

- T. Install sleeves for piping penetrations of walls, ceilings, and floors.
- U. Install sleeve seals for piping penetrations of concrete walls and slabs.
- V. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.
- H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Piping: Join according to ASTM D 2855.
- N. Joints for PEX Tubing: Join according to ASTM F 1807 for metal insert and copper crimp ring fittings and ASTM F 1960 for cold expansion fittings and reinforcing rings.
- O. Joints for PEX Tubing: Join according to ASSE 1061 for push-fit fittings.

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

### 3.3 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition.

### 3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples and unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

### 3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
  - 4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### 3.6 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

### 3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 ADJUSTING

A. Perform the following adjustments before operation:

- 1. Close drain valves, hydrants, and hose bibbs.
- 2. Open shutoff valves to fully open position.
- 3. Open throttling valves to proper setting.
- 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
  - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
  - b. Adjust calibrated balancing valves to flows indicated.
- 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
- 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
- 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.9 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
- 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Repeat procedures if biological examination shows contamination.
  - e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
  - 1. Soft copper tube, ASTM B 88, Type K.
  - 2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
- E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
  - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
  - 2. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
  - 3. Push-on-joint, ductile-iron pipe; standard- or compact-pattern, push-on-joint fittings; and gasketed joints.
  - 4. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
  - 5. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
- F. Under-building-slab, combined domestic water, building-service, NPS 6 to NPS 12, shall be one of the following:
  - 1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.
  - 2. Push-on-joint, ductile-iron pipe; standard- or compact-pattern, push-on-joint fittings; and gasketed joints.
  - 3. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
- G. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be one of the following:
  - 1. Copper tube, ASTM B 88, Type L.
  - 2. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
- H. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
  - 1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
  - 2. Hard copper tube, ASTM B 88, Type L; solder-joint fittings; and soldered joints.
  - 3. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
  - 4. Hard copper tube, ASTM B 88, Type L; copper push-on-joint fittings; and push-on joints.
  - 5. CPVC, Schedule 80; socket fittings; and solvent-cemented joints.
  - 6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
  - 7. CPVC Tubing System: CPVC tube; CPVC socket fittings; and solvent-cemented joints. NPS 1-1/2 and NPS 2 CPVC pipe with CPVC socket fittings may be used instead of tubing.
  - 8. PEX tube, NPS 1 and smaller.
    - a. Fittings for PEX tube:
      - 1) ASTM F 1807, metal insert and copper crimp rings.
      - 2) ASTM F 1960, cold expansion fittings and reinforcing rings.
      - 3) ASSE 1061, push-fit fittings.
  - 9. PE-AL-PE tube, NPS 1 and smaller; fittings for PE-AL-PE tube; and crimped joints
  - 10. PVC, Schedule 80; socket fittings; and solvent-cemented joints.
- I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
  - 1. Hard copper tube, ASTM B 88, Type L; solder-joint fittings; and soldered joints.
  - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
  - 3. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
  - 4. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
  - 5. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
  - 6. CPVC, Schedule 80 pipe; CPVC, Schedule 80 threaded fittings; and threaded joints.
  - 7. PVC, Schedule 80; socket fittings; and solvent-cemented joints.

3.11 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
  - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
  - 3. Hot-Water Circulation Piping, Balancing Duty: Balancing valves.
  - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

**SECTION 22 13 16**

**SANITARY WASTE AND VENT PIPING**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  1. Hub-and-spigot, cast-iron soil pipe and fittings.
  2. Hubless, cast-iron soil pipe and fittings.
  3. Ductile-iron pipe and fittings.
  4. PVC pipe and fittings.
  5. Specialty pipe fittings.
  6. Encasement for underground metal piping.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
  2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  1. Soil, Waste, and Vent Piping: 10-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74.



- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

#### 2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conine Manufacturing Co., Inc.
    - b. SE Sovent.
- C. CISPI, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Charlotte Pipe and Foundry Company.
    - c. Dallas Specialty & Mfg. Co.
    - d. Fernco Inc.
    - e. Josam Company.
    - f. Matco-Norca.
    - g. MIFAB, Inc.
    - h. Mission Rubber Company, LLC; a division of MCP Industries.
    - i. NewAge Casting.
    - j. Stant.
    - k. Tyler Pipe; a subsidiary of McWane Inc.
  - 2. Standards: ASTM C 1277 and CISPI 310.
  - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- D. Heavy-Duty, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ANACO-Husky.
    - b. Charlotte Pipe and Foundry Company.
    - c. Clamp-All Corp.
    - d. Dallas Specialty & Mfg. Co.
    - e. MIFAB, Inc.
    - f. Mission Rubber Company, LLC; a division of MCP Industries.
    - g. NewAge Casting.
    - h. Stant.
    - i. Tyler Pipe; a subsidiary of McWane Inc.
  - 2. Standards: ASTM C 1277 and ASTM C 1540.
  - 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- E. Cast-Iron, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Charlotte Pipe and Foundry Company.
    - b. MG Piping Products Company.
  - 2. Standard: ASTM C 1277.
  - 3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

#### 2.5 DUCTILE-IRON PIPE AND FITTINGS

- A. Ductile-Iron, Mechanical-Joint Piping:
  - 1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
  - 2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Ductile-Iron, Push-on-Joint Piping:
1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
  2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
  3. Gaskets: AWWA C111/A21.11, rubber.
- C. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.
- D. Ductile-Iron, Grooved-End Pipe Appurtenances:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. Shurjoint Piping Products USA Inc.
    - c. Smith-Cooper International.
    - d. Star Pipe Products.
    - e. Victaulic Company.
  2. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings, with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings, and complying with AWWA C606 for grooved ends.
  3. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.
- 2.6 PVC PIPE AND FITTINGS
- A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.
- B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
- C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
- D. Adhesive Primer: ASTM F 656.
- E. Solvent Cement: ASTM D 2564.
- 2.7 SPECIALTY PIPE FITTINGS
- A. Transition Couplings:
1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  2. Unshielded, Nonpressure Transition Couplings:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Dallas Specialty & Mfg. Co.
      - 2) Fernco Inc.
      - 3) Froet Industries LLC.
      - 4) Mission Rubber Company, LLC; a division of MCP Industries.
      - 5) Plastic Oddities.
    - b. Standard: ASTM C 1173.
    - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - d. End Connections: Same size as and compatible with pipes to be joined.
    - e. Sleeve Materials:
      - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

- 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  3. Shielded, Nonpressure Transition Couplings:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Cascade Waterworks Mfg. Co.
      - 2) Mission Rubber Company, LLC; a division of MCP Industries.
    - b. Standard: ASTM C 1460.
    - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - d. End Connections: Same size as and compatible with pipes to be joined.
  4. Pressure Transition Couplings:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Apollo Flow Controls; Conbraco Industries, Inc.
      - 2) Cascade Waterworks Mfg. Co.
      - 3) Dresser, Inc.
      - 4) EBAA Iron, Inc.
      - 5) Ford Meter Box Company, Inc. (The).
      - 6) Jay R. Smith Mfg. Co.
      - 7) JCM Industries, Inc.
      - 8) Romac Industries, Inc.
      - 9) Viking Johnson.
    - b. Standard: AWWA C219.
    - c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
    - d. Center-Sleeve Material: Manufacturer's standard.
    - e. Gasket Material: Natural or synthetic rubber.
    - f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:
1. Dielectric Unions:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) A.Y. McDonald Mfg. Co.
      - 2) Capitol Manufacturing Company.
      - 3) Central Plastics Company.
      - 4) HART Industrial Unions, LLC.
      - 5) Jomar Valve.
      - 6) Matco-Norca.
      - 7) WATTS.
      - 8) Wilkins.
      - 9) Zurn Industries, LLC.
    - b. Description:
      - 1) Standard: ASSE 1079.
      - 2) Pressure Rating: 250 psig.
      - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
  2. Dielectric Flanges:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Capitol Manufacturing Company.
      - 2) Central Plastics Company.
      - 3) Matco-Norca.
      - 4) WATTS.
      - 5) Wilkins.
      - 6) Zurn Industries, LLC.

- b. Description:
  - 1) Standard: ASSE 1079.
  - 2) Factory-fabricated, bolted, companion-flange assembly.
  - 3) Pressure Rating: 300 psig.
  - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- 3. Dielectric-Flange Insulating Kits:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Advance Products & Systems, Inc.
    - 2) Calpico, Inc.
    - 3) Central Plastics Company.
    - 4) Pipeline Seal and Insulator, Inc.
  - b. Description:
    - 1) Nonconducting materials for field assembly of companion flanges.
    - 2) Pressure Rating: 150 psig.
    - 3) Gasket: Neoprene or phenolic.
    - 4) Bolt Sleeves: Phenolic or polyethylene.
    - 5) Washers: Phenolic with steel backing washers.
- 4. Dielectric Nipples:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Elster Perfection Corporation.
    - 2) Grinnell Mechanical Products.
    - 3) Josam Company.
    - 4) Matco-Norca.
    - 5) Precision Plumbing Products.
    - 6) Victaulic Company.
  - b. Description:
    - 1) Standard: IAPMO PS 66.
    - 2) Electroplated steel nipple.
    - 3) Pressure Rating: 300 psig at 225 deg F.
    - 4) End Connections: Male threaded or grooved.
    - 5) Lining: Inert and noncorrosive, propylene.

### **PART 3 - EXECUTION**

#### **3.1 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  - 1. The design drawings are generally diagrammatic. They do not show every bend, off-set, elbow or other fitting which may be required in the piping for installation in the space allotted. Careful coordination of the work is necessary to avoid conflicts.
  - 2. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  - 3. Install piping as indicated unless deviations to layout are approved on coordination drawings.
  - 4. PVC piping, fittings and other PVC materials shall not be installed in air conditioning plenums or equipment rooms used as air conditioning plenums.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.

- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
  - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  - 3. Do not change direction of flow more than 90 degrees.
  - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
  - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
  - 1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
  - 2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
  - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
  - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- O. Install aboveground PVC piping according to ASTM D 2665.
- P. Install underground PVC piping according to ASTM D 2321.
- Q. Install engineered soil and waste and vent piping systems as follows:
  - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
  - 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
  - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- R. Install underground, ductile-iron, force-main piping according to AWWA C600.
  - 1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
  - 2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
  - 3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- S. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
  - 1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.
- T. Install force mains at elevations indicated.
- U. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

### 3.2 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
  - 1. Cut threads full and clean using sharp dies.
  - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    - c. Do not use pipe sections that have cracked or open welds.
- E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.
- F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
- I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
  - 3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.

### 3.3 VALVE INSTALLATION

- A. Comply with requirements in Section 22 05 23.12 "Ball Valves for Plumbing Piping" and Section 22 05 23.14 "Check Valves for Plumbing Piping," for general-duty valve installation requirements.
- B. Shutoff Valves:
  - 1. Install shutoff valve on each sewage pump discharge.
  - 2. Install gate or full-port ball valve for piping NPS 2 and smaller.
  - 3. Install gate valve for piping NPS 2-1/2 and larger.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- D. Backwater Valves: Install backwater valves in piping subject to backflow.
  - 1. Horizontal Piping: Horizontal backwater valves
  - 2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
  - 3. Install backwater valves in accessible locations.

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Vertical Piping shall be supported at its base and no greater than every story height, not to exceed 20 foot intervals.
- B. Horizontal Piping (Suspended) shall be supported at each bend; at not more than five (5) foot intervals; except that pipe exceeding five (5) feet in length may be supported at not more than ten (10) foot intervals.

Supports shall be adequate to maintain alignment and prevent sagging and shall be made directly behind the bell or coupling, where possible, not near the center of the pipe.

- C. Supports shall be connected to the building structure not from other equipment, ducts or conduits.
- D. Horizontal pipe and fittings six inches and larger shall be suitably braced to prevent horizontal movement. This should be done at every branch opening or change of direction by the use of braces, blocks, rodding or other suitable method, to prevent movement.
- E. Where components are suspended in excess of eighteen inches by means of non-rigid hangers, they should be suitably braced against movement horizontally, often called sway bracing.

### 3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
  - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
  - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
  - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
  - 5. Install horizontal backwater valves with cleanout cover flush with floor.
  - 6. Comply with requirements for backwater valves, cleanouts, and drains.
  - 7. Equipment: Connect waste piping as indicated.
    - a. Provide shutoff valve if indicated and union for each connection.
    - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Connect force-main piping to the following:
  - 1. Sanitary Sewer: To exterior force main.
  - 2. Sewage Pump: To sewage pump discharge.
- E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- F. Make connections according to the following unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### 3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

### 3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
  - C. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
    - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
      - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
    - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
      - a. Expose work that was covered or concealed before it was tested.
    - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
      - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
      - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
      - c. Inspect joints for leaks.
    - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
      - a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
      - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
      - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
      - d. Inspect plumbing fixture connections for gas and water leaks.
    - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  - D. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
    - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
      - a. Expose work that was covered or concealed before it was tested.
    - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
      - a. Isolate test source and allow to stand for four hours.
      - b. Leaks and loss in test pressure constitute defects that must be repaired.
    - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 3.8 CLEANING AND PROTECTION
- A. Clean interior of piping. Remove dirt and debris as work progresses.
  - B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
  - C. Place plugs in ends of uncompleted piping at end of day and when work stops.
  - D. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
  - E. Repair damage to adjacent materials caused by waste and vent piping installation.



3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 3 and smaller shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
  - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Aboveground, soil and waste piping NPS 4 and larger shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
  - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- D. Aboveground, vent piping NPS 3 and smaller shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
  - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- E. Aboveground, vent piping NPS 4 and larger shall be any of the following:
  - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
  - 3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- F. Underground, soil, waste, and vent piping NPS 3 and smaller shall be any of the following:
  - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; and coupled joints.
  - 3. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- G. Underground, soil and waste piping NPS 4 and larger shall be any of the following:
  - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
  - 2. Hubless, cast-iron soil pipe and fittings; hubless-piping couplings; coupled joints.
  - 3. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
- H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be the following:
  - 1. Galvanized-steel pipe, pressure fittings, and threaded joints.
- I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be the following:
  - 1. Grooved-end, galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- J. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:
  - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
  - 2. Ductile-iron, mechanical-joint piping and mechanical joints.
  - 3. Ductile-iron, push-on-joint piping and push-on joints.
  - 4. Ductile-iron, grooved-joint piping and grooved joints.
  - 5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.
- K. Underground sanitary-sewage force mains NPS 5 and larger shall be any of the following:
  - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
  - 2. Ductile-iron, mechanical-joint piping and mechanical joints.
  - 3. Ductile-iron, push-on-joint piping and push-on joints.
  - 4. Ductile-iron, grooved-joint piping and grooved joints.
  - 5. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION

**SECTION 22 13 19.13**

**SANITARY DRAINS**

**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. Floor drains.
  - 2. Floor sinks.
  - 3. Trench drains.

1.3 DEFINITIONS

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

- A. .Submit manufacturer's data for review before any work is commenced

1.5 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

**PART 2 - PRODUCTS**

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. WATTS.
    - d. Zurn Industries, LLC.
  - 2. Standard: ASME A112.6.3
- B. Stainless-Steel Floor Drains, ASME A112.3.1
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Zurn Industries, LLC.
- C. Stainless-Steel Floor Drains, ASME A112.6.3
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Jay R. Smith Mfg. Co.
    - b. Josam Company.
    - c. Sioux Chief Manufacturing Company, Inc.
    - d. WATTS.

- e. Zurn Industries, LLC.

## 2.3 FLOOR SINKS

### A. Cast-Iron Floor Sinks

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company.
  - b. Wade; a subsidiary of McWane Inc.
  - c. Watts; a Watts Water Technologies company.
  - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.7.

### B. Stainless-Steel Floor Sinks, ASME A112.6.7 :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Josam Company.
  - b. Watts; a Watts Water Technologies company.
  - c. Zurn Industries, LLC.
2. Standard: ASME A112.6.7.

## 2.4 TRENCH DRAINS

### A. Trench Drains

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Sioux Chief Manufacturing Company, Inc.
  - e. Wade; a subsidiary of McWane Inc.
  - f. WATTS.
  - g. Zurn Industries, LLC.
2. Standard: ASME A112.6.3 for trench drains.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  1. Position floor drains for easy access and maintenance.
  2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
  3. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
    - a. Maintain integrity of waterproof membranes where penetrated.
  5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
  1. Set grates of drains flush with finished surface, unless otherwise indicated.

### 3.2 CONNECTIONS

- A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Comply with requirements for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment to allow service and maintenance.

### 3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

### 3.5 TRAP PRIMERS

- A. Trap primer outlet should extend vertically a minimum of 12" before a change in direction to horizontal is made. The horizontal line to the trap primer connection shall be installed sloping to the trap it serves. Provide a minimum size of 12" x 12" stainless steel access cover for each trap primer.

END OF SECTION

**SECTION 22 33 00**

**ELECTRIC, DOMESTIC-WATER HEATERS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.3 SUMMARY

- A. Section Includes:
  - 1. Flow-control, electric, tankless, domestic-water heaters.
  - 2. Thermostat-control, electric, tankless, domestic-water heaters.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

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

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.
  - a. Electric, Tankless, Domestic-Water Heaters: Five year(s).
  - b. Compression Tanks: Five years.

## **PART 2 - PRODUCTS**

### 2.1 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

- A. Flow-Control, Electric, Tankless, Domestic-Water Heaters:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eemax, Inc.
    - b. Chronomite Laboratories, Inc.
  2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
  3. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
    - a. Connections: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: 150 psig.
    - c. Heating Element: Resistance heating system.
    - d. Temperature Control: Flow-control fitting.
    - e. Safety Control: High-temperature-limit cutoff device or system.
    - f. Jacket: Aluminum or steel with enameled finish or plastic.
  4. Support: Bracket for wall mounting.
- B. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Eemax, Inc.
    - b. Chronomite Laboratories, Inc.
  2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
  3. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.
    - a. Connections: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: 150 psig.
    - c. Heating Element: Resistance heating system.
    - d. Temperature Control: Thermostat.
    - e. Safety Control: High-temperature-limit cutoff device or system.
    - f. Jacket: Aluminum or steel with enameled finish or plastic.
  4. Support: Bracket for wall mounting.

### 2.2 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

## **PART 3 - EXECUTION**

### 3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches above floor on wall bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

### 3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

### 3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

### 3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
  2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 01 40 00 "Quality Requirements" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.
- C. Prepare test and inspection reports.

END OF SECTION

**SECTION 22 42 13.13**

**COMMERCIAL WATER CLOSETS**

**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. Water closets.
  - 2. Toilet seats.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications

1.4 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.

**PART 2 - PRODUCTS**

2.1 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

- A. Water Closets: Floor mounted, bottom outlet, close-coupled flushometer tank.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Kohler Co.
    - c. Zurn Industries, LLC.
  - 2. Bowl:
    - a. Standards: ASME A112.19.2/CSA B45.1 and ASSE/ASME 1037/CSA B125.37.
    - b. Material: Vitreous china.
    - c. Type: Siphon jet.
    - d. Style: Pressure assisted.

2.2 TOILET SEATS

- A. Toilet Seats:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Bemis Manufacturing Company.
    - c. Centoco Manufacturing Corporation.
    - d. Church Seats; Bemis Manufacturing Company.
    - e. Kohler Co.
    - f. Olsonite Seat Co.
    - g. TOTO USA, INC.
    - h. Zurn Industries, LLC.
  - 2. Standard: IAPMO/ANSI Z124.5.
  - 3. Material: Plastic.



**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Water-Closet Installation:
  - 1. Install level and plumb according to roughing-in drawings.
  - 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
- B. Install toilet seats on water closets.
- C. Escutcheon Installation:
  - 1. Install escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
  - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- D. Joint Sealing:
  - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
  - 2. Match sealant color to water-closet color.
  - 3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

**3.2 CONNECTIONS**

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

**3.3 ADJUSTING**

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

**3.4 CLEANING AND PROTECTION**

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

**SECTION 22 42 13.16**

**COMMERCIAL URINALS**

**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. Urinals.
  - 2. Flushometer valves.
  - 3. Supports.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. Flush valves and water closet seats shall be as scheduled on the drawings

2.2 WALL-HUNG URINALS

- A. Urinals: Wall hung:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Gerber Plumbing Fixtures LLC.
    - c. Kohler Co.
  - 2. Fixture:
    - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
    - b. Material: Vitreous china.
  - 3. Waste Fitting:
    - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
    - b. Size: NPS 2.

2.3 URINAL FLUSHOMETER VALVES

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Kohler
  - b. American standard.
  - c. Sloan Valve Company.
  - d. Zurn Industries, LLC.
- 2. Standard: ASSE 1037.
- 3. Minimum Pressure Rating: 125 psig.
- 4. Features: Include integral check stop and backflow-prevention device.
- 5. Material: Brass body with corrosion-resistant components.

2.4 SUPPORTS

- A. Type I Urinal Carrier:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. Wade Drains.
    - d. WATTS.
    - e. Zurn Industries, LLC.
  - 2. Standard: ASME A112.6.1M.
- B. Type II Urinal Carrier:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. Wade Drains.
    - d. WATTS.
    - e. Zurn Industries, LLC.
  - 2. Standard: ASME A112.6.1M.
- C. Type I Sink Carrier:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. Wade Drains.
    - d. WATTS.
    - e. Zurn Industries, LLC.
  - 2. Standard: ASME A112.6.1M.

**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Urinal Installation:
  - 1. Install urinals level and plumb according to roughing-in drawings.
  - 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
  - 3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
  - 4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
  - 5. Install trap-seal liquid in waterless urinals.
- B. Support Installation:
  - 1. Install supports, affixed to building substrate, for wall-hung urinals.
  - 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
  - 3. Use carriers without waste fitting for urinals with tubular waste piping.
  - 4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
- C. Flushometer-Valve Installation:
  - 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
  - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION

**SECTION 22 42 16.13**

**COMMERCIAL LAVATORIES**

**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. Lavatories.
  - 2. Faucets.
  - 3. Supply fittings.
  - 4. Waste fittings.
  - 5. Supports.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.

**PART 2 - PRODUCTS**

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory, Rectangular, self-rimming, vitreous china, counter mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Crane Plumbing, L.L.C.
    - c. Gerber Plumbing Fixtures LLC.
    - d. Kohler Co.
    - e. Mansfield Plumbing Products LLC.
    - f. TOTO USA, INC.
  - 2. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.
- B. Lavatory : self-rimming, vitreous china, counter mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Briggs Plumbing Products, Inc.
    - c. Crane Plumbing, L.L.C.
    - d. Gerber Plumbing Fixtures LLC.
    - e. Kohler Co.
    - f. Mansfield Plumbing Products LLC.
    - g. Peerless Pottery Sales, Inc.
    - h. TOTO USA, INC.
    - i. Zurn Industries, LLC.
  - 2. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.

- C. Lavatory: Oval, vitreous china, undercounter mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Crane Plumbing, L.L.C.
    - c. Gerber Plumbing Fixtures LLC.
    - d. Kohler Co.
    - e. Mansfield Plumbing Products LLC.
    - f. Peerless Pottery Sales, Inc.
    - g. Sloan Valve Company.
    - h. TOTO USA, INC.
    - i. Zurn Industries, LLC.
  - 2. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.

## 2.2 WALL-MOUNTED LAVATORIES

- A. Lavatory : Vitreous china, wall mounted, with back.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Briggs Plumbing Products, Inc.
    - c. Crane Plumbing, L.L.C.
    - d. Gerber Plumbing Fixtures LLC.
    - e. Kohler Co.
    - f. Mansfield Plumbing Products LLC.
    - g. Peerless Pottery Sales, Inc.
    - h. Sloan Valve Company.
    - i. Zurn Industries, LLC.
  - 2. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.
    - b. Type: For wall hanging.
- B. Lavatory : Wheelchair, vitreous china, wall mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Crane Plumbing, L.L.C.
    - c. Gerber Plumbing Fixtures LLC.
    - d. Kohler Co.
    - e. Mansfield Plumbing Products LLC.
    - f. Peerless Pottery Sales, Inc.
    - g. Sloan Valve Company.
    - h. Zurn Industries, LLC.
  - 2. Fixture:
    - a. Standard: ASME A112.19.2/CSA B45.1.
    - b. Type: Slab or wheelchair.
  - 3. Lavatory Mounting Height: Handicapped/elderly according to ICC A117.1.

## 2.3 SOLID-BRASS, MANUALLY OPERATED FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets : solid-brass valve.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Bradley Corporation.
    - c. Chicago Faucets; Geberit Company.
    - d. Delta Faucet Company.
    - e. Elkay Manufacturing Co.
    - f. Gerber Plumbing Fixtures LLC.
    - g. GROHE America, Inc.

- h. Kohler Co.
- i. Moen Incorporated.
- j. Speakman Company.
- k. Zurn Industries, LLC.

- 2. Standard: ASME A112.18.1/CSA B125.1.
- 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.

#### 2.4 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets: Automatic-type, battery-powered, electronic-sensor-operated, mixing, solid-brass valve.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Bradley Corporation.
    - c. Chicago Faucets; Geberit Company.
    - d. Gerber Plumbing Fixtures LLC.
    - e. GROHE America, Inc.
    - f. Hydrotek International, Inc.
    - g. Kohler Co.
    - h. Moen Incorporated.
    - i. Sloan Valve Company.
    - j. Speakman Company.
    - k. TOTO USA, INC.
    - l. Zurn Industries, LLC.
  - 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
  - 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.

#### 2.5 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AM Conservation Group, Inc.
  - 2. Chronomite Laboratories, Inc.
  - 3. NEOPERL, Inc.
  - 4. T&S Brass and Bronze Works, Inc.
- C. Description: Chrome-plated-brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

#### 2.6 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Standard: ASME A112.18.2/CSA B125.2.

- F. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

## 2.7 SUPPORTS

- A. Type II Lavatory Carrier:
  - 1. Standard: ASME A112.6.1M.
- B. Type III Lavatory Carrier:
  - 1. Standard: ASME A112.6.1M.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

### 3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### 3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.



- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

**SECTION 22 42 16.16**

**COMMERCIAL SINKS**

**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. Service basins.
  - 2. Service sinks.
  - 3. Utility sinks.
  - 4. Sink faucets.
  - 5. Laminar-flow, faucet-spout outlets.
  - 6. Supports.
  - 7. Supply fittings.
  - 8. Waste fittings.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Plumbing Provisions", for related requirements. Refer to other sections of Division 22 and to all other applicable portions of the Drawings and Specifications.

1.4 SUBMITTALS

- A. Submit manufacturer's data for review before any work is commenced.

1.5 SERVICE BASINS

- A. Service Basins: Terrazzo, floor mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Acorn Engineering Company.
    - b. Crane Plumbing, L.L.C.
    - c. Florestone Products Co., Inc.
  - 2. Fixture:
    - a. Standard: IAPMO PS 99.
  - 3. Mounting: On floor and flush to wall.

1.6 SERVICE SINKS

- A. Service Sinks: Enameled, cast iron, trap standard mounted.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Standard.
    - b. Commercial Enameling Company.
    - c. Gerber Plumbing Fixtures LLC.
    - d. Kohler Co.
    - e. Zurn Industries, LLC.
  - 2. Fixture:
    - a. Standard: ASME A112.19.1/CSA B45.2.

1.7 UTILITY SINKS

- A. Utility Sinks: Stainless steel, counter mounted.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Tabco.
  - b. Elkay Manufacturing Co.
  - c. Just Manufacturing.
2. Fixture:
  - a. Standard: ASME A112.19.3/CSA B45.4.
3. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
4. Waste Fittings:
  - a. Standard: ASME A112.18.2/CSA B125.2.

B. Utility Sinks: Stainless steel, freestanding.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Tabco.
  - b. Elkay Manufacturing Co.
  - c. Just Manufacturing.
2. Fixture:
  - a. Standard: ASME A112.19.3/CSA B45.4.
3. Supply Fittings:
  - a. Standard: ASME A112.18.1/CSA B125.1.
  - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
4. Waste Fittings:
  - a. Standard: ASME A112.18.2/CSA B125.2.

1.8 SINK FAUCETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets: Manual type, mixing valve.
  1. Commercial, Solid-Brass Faucets:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) American Standard.
      - 2) Kohler Co.
      - 3) Moen Incorporated.
      - 4) Sloan Valve Company.
  2. General-Duty, Solid-Brass Faucets:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) American Standard.
      - 2) Elkay Manufacturing Co.
      - 3) Hydrotek International, Inc.
      - 4) Kohler Co.
      - 5) Moen Incorporated.
      - 6) Zurn Industries, LLC.

1.9 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

- A. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. AM Conservation Group, Inc.

2. Chronomite Laboratories, Inc.
3. T&S Brass and Bronze Works, Inc.

C. Description: Chrome-plated brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

#### 1.10 SUPPORTS

A. Type II Sink Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Wade Drains.
  - e. WATTS.
  - f. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

#### 1.11 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

#### 1.12 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
  1. Size: NPS 1-1/2.
  2. Material: Chrome-plated, and chrome-plated brass or steel wall flange.
  3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

#### 1.13 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

### **PART 2 - EXECUTION**

#### 2.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

## 2.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
  - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping."
  - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Indicate on Drawings those sinks that are required to be accessible.
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."

## 2.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

## 2.4 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

## 2.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

**SECTION 23 01 00**

**GENERAL MECHANICAL PROVISIONS**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

**1.2 SCOPE OF DIVISION**

- A. Work shall include all materials, equipment and labor necessary for a complete and properly functioning mechanical installation in accordance with all applicable codes, and contract drawings and specifications. Work shall include all work specified in Division-23, HVAC.
- B. Pay for all required licenses, fees, inspections and permits.

**1.3 RELATION TO OTHER WORK**

- A. Work Not in Division 23: Related work not included in this division consists of requirements given in the following as may be included in the contract documents:
  - 1. Other divisions which may include work (such as concrete, steel, painting, ceiling systems, structure and other work) related to the work of Division 23.
- B. Work of Division 23: Any or all sections of Division 23 may include a paragraph or paragraphs under the heading, "Relation to other Work". Where such a paragraph is indicated and work directly related to the section is listed or described, such work shall be considered as relating directly to the indicated section. Any related work (directly related or otherwise) which may be omitted by reference from the "Relation to Other Work" paragraph of such section(s), shall be provided as necessary and required whether or not such work is included by reference. Such listing or description of related work within a section is given only as a convenience to the Contractor; omission of other related sections or described work does not in any way exclude the provision of such work.
- C. The mechanical contractor shall coordinate with the controls vendor for all control related equipment that is provided by the controls vendor and installed by the mechanical contractor. Refer to specification 23 09 23 for list of controls vendor supplied items to be installed by the mechanical contractor.

**1.4 CODES**

- A. Install all work in accordance with the latest edition of all applicable regulations and governing codes, including the regulations of the utility companies serving the project.
- B. Where a conflict in code requirements occurs the more stringent requirement shall govern.

**1.5 STANDARDS**

- A. All equipment and devices shall bear U.L. label, the label of an industry recognized approved testing agency or A.G.A. certification for said item of equipment or device.
- B. All electrical devices must be U.L. approved.

**1.6 DRAWINGS**

- A. Architectural and structural drawings take precedence over mechanical drawings with reference to the building construction. Mechanical drawings are diagrammatic and indicate the general arrangement and extent of work. Architectural drawings indicate more exactly the desired relationship between diffusers, registers, lighting fixtures, equipment, electric panels and devices, plumbing fixtures, and other items which remain exposed in the completed building. Exact locations and arrangement of materials and equipment shall be determined, with the acceptance of the Architect/Engineer, as work progresses to conform in the best possible manner with the surroundings and with the adjoining work of other trades.

Where locations of equipment, devices or fixtures are controlled by architectural features, establish such locations by referring to dimensions on Architectural drawings and not by scaling drawings.

## 1.7 DISCREPANCIES

- A. In case of differences between drawings and specifications, or where drawings and specifications are not clear or definitive, the more stringent requirement shall apply. Any such discrepancies shall be referred to Architect/Engineer for clarification and instructions.

## 1.8 ELECTRICAL PROVISIONS

- A. Work of Division 23 shall include the electrical requirements which are indicated to be integral with mechanical work and which can be summarized to include (but not necessarily be limited to) the following:
  - 1. Motors
  - 2. Unless shown otherwise, motor starters are to be furnished by mechanical contractor, installed by electrical contractor.
  - 3. In lieu of the mechanical contractor furnishing motor starters, the mechanical contractor can coordinate with the electrical contractor where the electrical contractor furnishes and installs a combination motor starter / disconnect switch.
  - 4. Control switch, pilot lights, interlocks and similar devices.
  - 5. Electrical heating coils and similar elements in mechanical equipment.
  - 6. Electrical work specified in Division-23 for the HVAC control system.
  - 7. Drip pans to protect electrical work.
- B. Motors, Starters, Switches:
  - 1. All motors 1HP and above associated with mechanical equipment that are not being provided with a variable frequency drive shall be provided with a motor starter.
  - 2. For motors under 1HP that are required to be controlled shall be coordinated with the building automation system to ensure start / stop control is achieved. Provide all relays, wiring and devices as required to achieve desired control.
- C. Drip Pans: Where possible, do not run mechanical piping directly above electrical (or electronic) equipment which is sensitive to moisture; otherwise provide drip pans under mechanical piping. Locate pan below piping and extend 6" on each side of piping and lengthwise 18" beyond equipment. Fabricate pans 2" deep, of reinforced sheet metal with rolled edges and soldered or welded seams; 20 gage copper, or 16 gage steel with 2 oz. zinc finish hot dipped after fabrication. Provide 3/4" copper drainage piping, properly discharged to a waste receptor.
- D. Motors: Refer to "Electric Motors, Premium Efficiency Type".

## 1.9 ELECTRICAL/MECHANICAL WORK

- A. Definitions: Definitions for the purpose of mechanical/electrical control and power coordination are as follows: (Note: The use of the words, "Provide", "furnish" and "install" are intended only for use in describing the coordination indicated by this paragraph and do not necessarily have the same definitions when used outside of the context of this paragraph.) Any items which do not fall within the scope of this paragraph shall be coordinated as individually specified.
  - 1. "Furnish" means to procure an item and to deliver it to the project for installation.
  - 2. "Install" means to determine (in coordination with others as necessary) the appropriate intended location of an item and to set and connect it in place.
  - 3. "Provide" means to both furnish and install.
  - 4. Power Circuit: Circuit which carries main electric power to apparatus to which the power circuit is connected.
  - 5. Control Circuit: Circuit which carries electrical signals directing the performance of a controller, but which does not carry the main electric power. (See NEC, Section 430-71.) Such circuits shall also include those which serve a dual control and power function (e.g., a line voltage thermostat circuit which both activates and powers a small fan motor).
  - 6. Controller: A device, or group of devices, which serves to govern, in some predetermined manner, electric power delivered to apparatus to which the controller is connected and includes any switch or device normally used to start and stop a motor. (See NEC, Article 100, Definitions, "Controller", and Section 430-81(a).)

7. Control Device: A device which reacts to an operating condition (pressure, temperature, flow, humidity, etc.) and which initiates transmission of an electrical control signal which causes operation of a controller or which causes operation of pressure switches, etc.
8. Auxiliary Control Device: A device (such as a low voltage control transformer, electric relay, etc.) which is located in a control circuit and which carries or responds to (but does not initiate) an electrical control signal initiated by a control device.

B. Work of Division-23 includes (but is not necessarily limited to):

1. Provide:
  - a. All controllers which are generally manufactured or shipped as integral with Division-23 equipment (such as starters packaged with chillers, etc.).
  - b. All electric motors and other electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.) which are specified in Division 23.
  - c. All control circuits (including conduit and boxes) from the Division-26 panels to point of use including the necessary circuit breakers.
  - d. All other control circuits, including conduit and boxes.
  - e. All control connections to equipment.
  - f. All control connections to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
  - g. Auxiliary control devices.
  - h. All control devices (thermostats, pressure switches, flow switches, humidistats, etc.) and make control circuit connections thereto.
  - i. Any and all pneumatic and electronic and electric control devices and electric or pneumatic connections thereto.
2. Furnish:
  - a. All controllers which are generally manufactured and/or shipped as separate but companion items to Division-23 equipment (such as centrifugal chiller starters which are matched with the chillers but are not physically an integral part of the chiller assembly.)

C. Work of Division-26 includes (but is not necessarily limited to):

1. Provide:
  - a. All power circuits, including conduit and boxes.
  - b. All power connections to controllers, switches, motors and other mechanical systems electrical power consuming equipment (such as electric air heating coils, electric boilers, electric hot water heaters, etc.).
  - c. All remote motor disconnects (remote from the related controller) at all locations required by NEC and connections thereto except those disconnects which are specified in Division-23 to be provided as part of the equipment itself.
  - d. If coordinated with the mechanical contractor, all combination starter / disconnect switches required for mechanical motors.
  - e. All controllers (except those which are generally manufactured or shipped as separate but companion items to Division-23 equipment such as centrifugal chiller starters).
2. Install:
  - a. All controllers which are generally manufactured and/or shipped as separate but companion items to Division-23 equipment (e.g., chiller starters).
  - b. Motor starters or variable frequency drives furnished by the mechanical contractor for motors associated with mechanical equipment.

1.10 AUXILIARIES AND ACCESSORIES

- A. Include all auxiliaries and accessories for complete and properly operating systems.

1.11 INVESTIGATION OF SITE

- A. Check site and existing conditions thoroughly before bidding. Advise Architect/Engineer of discrepancies or questions noted before bidding.

1.12 ASBESTOS

- A. Should asbestos, or any other hazardous waste material, be encountered during the execution of the work, or should the presence of asbestos or any other hazardous material be suspected, immediately



notify the Owner and suspend all work in the affected area. The Owner will activate an assessment study to determine the presence of asbestos, or other hazardous material, and evaluate what condition it is in. Removal of asbestos, or other hazardous material, if required, will be conducted by a qualified Contractor, and will be done under separate contract.

1.13 COORDINATION

- A. Provide all required coordination and supervision where work of this division connects to or is affected by work of others.

1.14 PROVISIONS FOR OPENINGS

- A. Provide all openings required for work performed under Division-23. Provide sleeves or other approved methods to allow passage of items installed under any Section of Division-23.

1.15 INTERRUPTION OF EXISTING SERVICES

- A. Any interruption of existing services shall be coordinated in advance with the Owner's Representative. Shutdown time and duration of critical services shall be decided by the Owner. Contractor shall provide shutoff valves at point of tie-in to minimize downtime.

1.16 CLEANING AND PROTECTION

- A. Ductwork: Keep the interior of the duct system free from dirt and rubbish and other foreign matter. All fan motors, switches, and other items shall also be protected from dirt, rubbish and other foreign matter during building construction. Thoroughly clean all components of the ductwork and remove all dirt, scale, oil and other foreign substances which may have accumulated during the installation process.
- B. Equipment: All mechanical equipment provided shall be thoroughly cleaned of all dirt, oil, concrete, etc. Any dents, scratches or other visible blemishes shall be corrected, and the appearance of the equipment made "like new" and to the satisfaction of the Architect/Engineer.
- C. Upon completion, and before final acceptance of the work, all debris, rubbish, leftover materials, tools and equipment shall be removed from the site.
- D. Protection of Work Until Final Acceptance: Protect all materials and equipment from damage, entrance of dirt and construction debris from the time of installation until final acceptance. Any materials and equipment which are damaged shall be repaired to "as new" condition or replaced at the direction of the Architect/Engineer. Where factory finishes occur and damage is minor, finishes may be touched up. If, in the opinion of the Architect/Engineer the damage is excessive, factory finish shall be replaced to "new" condition.

1.17 SHOP DRAWINGS

- A. Submit shop drawings for all items, services and systems included in the project.
- B. Shop drawings shall clearly show the following:
  - 1. Technical and descriptive data in detail equal to or greater than the data given in the item specification. Indicate all characteristics, special modifications and features. Where performance and characteristic data is shown on the drawings or specified, submitted data shall be provided in a degree which is both quantitatively and qualitatively equal to that specified and shown so that comparison can be made. Present data in detail equal to or greater than that given in item specification and include all weights, deflections, speeds, velocities, pressure drops, operating temperatures, operating curves, temperature ranges, sound ratings, dimensions, sizes, manufacturers' names, model numbers, types of material used, operating pressures, full load amperages, starting amperages, fouling factors, capacities, set points, chemical compositions, certifications and endorsements, operating voltages, thicknesses, gauges and all other related information as applicable to particular item.
  - 2. Exceptions to or deviations from the contract documents. Should Architect/Engineer accept any items having such deviations which are not clearly brought to Architect/Engineer's attention, in writing, on item submittal, then Contractor is responsible for correction of such deviations regardless of when such deviations are discovered.
- C. Additional Requirements: See specific sections of the Specifications for any additional requirements.

1.18 SHOP DRAWINGS TECHNICAL INFORMATION SUBMITTALS

- A. All submittals are to be submitted electronically in the form of PDF. Electronic submittal file names must be formatted with the specification section number followed by the title of the specification section. One PDF file shall be provided for each specification section that requires submittals to be provided.
- B. A cover page shall have adequate space for Contractor, Subcontractor and Engineer review stamps and indicate the following minimum data:
  - 1. Project Name
  - 2. Project Address
  - 3. Contractor Name
  - 4. Subcontractor Name
  - 5. Specification Section Number
  - 6. Specification Section Name
  - 7. Submittal Date
- C. All shop drawings and equipment submittals shall be submitted complete based on specification division. Partial submittals of each specification section will not be accepted.
- D. All submittals shall have been reviewed for compliance by the Contractor and associated subcontractor prior to submission to the Engineer. A stamp bearing the name of the reviewer and date review was completed shall be on the cover page of the submittal.
- E. Submittal data shall be logically grouped based on equipment tags or like material. For submittals that contain data on multiple materials or equipment, it shall be clearly noted by equipment tag or applicable material.
- F. Manufacturer's data indicating multiple options or choices shall be clearly noted as to what is applicable to the material and equipment being provided. Information not applicable should be struck through or extracted.

1.19 SHOP DRAWINGS FOR PIPING SYSTEMS AND DUCT SYSTEMS

- A. Shop drawings for piping systems and duct systems shall be performed by the installing subcontractors. Shop drawings shall show all required maintenance and operational clearances required. Title drawings shall include identification of project and names of Architect, Engineer, Contractor, subcontractor and/or supplier, date, be numbered sequentially and shall indicate the following:
  - 1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
    - a. Fabrication and Erection dimensions.
    - b. Arrangements and sectional views.
    - c. Necessary details, including complete information for making connections with other work.
    - d. Kinds of materials and finishes.
    - e. Descriptive names of equipment.
    - f. Modifications and options to standard equipment required by the contract.
- B. Also provide shop drawings, using architectural reflected ceiling plans, which indicate locations of the following (to be verified by Contractor): Air distribution devices, sprinkler heads, lights, access panels, fire alarm, speakers, projectors or any system device intended to be installed in the ceiling.
- C. Shop drawings shall be submitted in electronic PDF format and shall bear the review stamp from the mechanical subcontractor and general contractor / CM that it has been reviewed for compliance.
- D. See specific sections of specifications for further requirements.

1.20 AIR HANDLING UNIT AND DUCTWORK CONFIGURATION SHOP DRAWINGS

- A. Contractor shall submit a shop drawing for all system and shall meet the following requirements:
  - 1. Be drawn at not less than a scale of 1/4" = 1'-0". Contractor may elect to use a larger scale if he desires (i.e., if drawing of unit is at 1/4" = 1'-0", 1/2" = 1'-0" may be used.).
  - 2. Clearly show all proposed ductwork configuration changes (sizes, routing, and similar differences) which are different in any respect from the Drawings.
  - 3. Where proposed changes affect any other work such as structure, housekeeping pads, piping, equipment, electrical work or any other work, shop drawings shall clearly show those proposed changes.

4. Where Drawings show units in plan only, shop drawings shall show proposed units in plan and also in elevation.
5. Shop drawings shall also show exact locations of related work (such as bar joists, columns, beams, sound attenuators, and like items) which affect the proposed ductwork routing and unit location and configuration.
6. Each section of each air handling unit shall be clearly identified (i.e., coil section, fan section, filter section, mixing box section, etc.).

- B. Failure to submit these shop drawings together at the same time with the air handling unit shop drawings will result in total disapproval of the proposed air handling units. Time delays or other reasons will not be considered.
- C. Shop drawings shall be submitted in electronic PDF format and shall bear the review stamp from the mechanical subcontractor and Contractor that it has been reviewed for compliance.

#### 1.21 ELECTRONIC FILES

- A. CADD files will be available on a limited basis to qualified firms at the Architect's / Engineer's prerogative. Recipients are cautioned that these files may not accurately show actual conditions as constructed. Users are responsible to verify actual field conditions. These files are not intended to be used as shop drawings.
- B. Any requests for electronic files shall be preceded by processing the required electronic file release form and submitting to the Engineer for authorization. Request for electronic files should be submitted through the Contractor for submission to the Architect / Engineer.

#### 1.22 OPERATING INSTRUCTIONS

- A. Submit for checking a specific set of written operating instructions on each item which requires instructions to operate. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe operating instructions.

#### 1.23 MAINTENANCE INFORMATION

- A. Submit for acceptance Maintenance Information consisting of manufacturer's printed instruction and parts lists for each major item of equipment. After acceptance, insert information in each Technical Information Brochure. Refer also to other sections which may describe maintenance.

#### 1.24 MANUFACTURER'S CHECK-OUT

- A. Check out by Manufacturer's Representative (for major items of equipment): At completion of construction and after performance verification information as above-mentioned has been gathered, submitted and accepted, provide one copy of this information to the manufacturer's representative. Work required under this section shall include having the representative examine the performance verification information, check the equipment in the field while it is operating, and sign a Check-Out Memo for record. Submit a copy of the memo on each major item of equipment for each brochure. Accepted memos shall be inserted on each brochure with the performance verification information and submittal data. Memos shall be submitted and accepted before Instruction in Operation to Owner or a request for final inspection.

#### 1.25 SYSTEM GUARANTEE

- A. The work required under Division-23 shall include a one-year guarantee. This guarantee shall be by the Contractor to the Owner to replace for the Owner any defective workmanship, equipment, or material which has been furnished under this Contract at no cost to the Owner for a period of one year from the date of acceptance of the System. This guarantee shall also include reasonable adjustments of the system required for proper operation during the guarantee period. Explain the provisions of guarantee to Owner at the "Instruction in Operation Conference".

#### 1.26 INSTRUCTION TO OWNER

- A. Submit all required items for checking one week before final inspection of the building is scheduled. When all items are accepted and placed in the proper brochures, the Contractor shall give notice in writing that he is ready to give the Owner an "Instruction in Operation Conference". After the above mentioned request is received the Contractor will be notified of the time the conference can be held with the Owner. At the conference, the Contractor shall review with the Owner all appropriate information. At the end of

the conference, seven copies of a memo certifying Instruction in Operation and Completed Demonstration shall be signed by the Contractor, Subcontractor and Owner and one copy inserted in each brochure.

## 1.27 MATERIALS AND EQUIPMENT

- A. Each bidder represents that his bid is based upon the materials and equipment described in this division of the specifications.
  - 1. Submittal shall include the name of the material or equipment for which it is to be substituted, substituted equipment model numbers, drawings, cuts, performance and test data and any other data or information necessary for the Architect/Engineer to determine that the equipment meets all specification and requirements. If the Architect/Engineer accepts any proposed substitutions, such acceptance will be set forth in writing.
  - 2. Substituted equipment with all accessories installed or optional equipment where permitted and accepted, must conform to space requirements. Any substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at the Contractor's expense. Any modifications of related systems of this or other trades as a result of substitutions shall be made at the Contractor's expense, and Contractor shall so state in his written request for substitution.
  
- B. Acceptable Manufacturers: Materials and Equipment specified in these contract documents are accepted only in regard to general performance and quality. It shall be the Contractor's responsibility to ensure that acceptable materials and equipment meet or exceed the efficiencies, capacities, electrical characteristics, performance and quality of the equipment herein specified. Acceptable equipment must also generally conform, without extensive modification of related systems to the accessories, weights, space and maintenance requirements, etc., of the specified equipment. Any modification to related systems of this or other trades shall be made at the Contractor's expense and the Contractor shall be responsible for coordination between trades. Any difference in capacity, efficiency, electrical characteristics, weights or quality of product, etc., between specified materials and equipment and acceptable alternates shall be submitted to the Architect/Engineer for acceptance within 30 days of Notice to Proceed.
  
- C. If no prior approval for substitutions or alternate manufacturers have been provided, the bid must conform with the requirements of the plans and specifications. No equipment substitutions or alternate manufacturers will be considered once the project bidding has ended.

## **PART 2 - PRODUCTS**

2.1 Section part not applicable.

## **PART 3 - EXECUTION**

3.1 Section part not applicable.

END OF SECTION

**SECTION 23 05 00**

**BASIC MECHANICAL MATERIALS AND METHODS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section, in addition to the following:

1.2 SCOPE

- A. Materials listed herein are general mechanical materials to be used under the Division 23 sections of the specifications unless specifically noted otherwise in the particular section or on the drawings.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications. This section relates to all sections of Division 23 as may be applicable to the work of each section.

1.4 STANDARDS

- A. Quality and weight of materials shall comply with requirements and specifications of the appropriate standards of the American Society of Testing and Materials.

**PART 2 - PRODUCTS**

2.1 MATERIALS AND EQUIPMENT, GENERAL

- A. All materials and equipment shall be new and without blemish or defect.
- B. Equipment and materials shall be products which will meet with the acceptance of the agency inspecting the work. Where acceptance is contingent upon having the products examined, tested and certified by Underwriters Laboratory or other recognized testing laboratory, the product shall be so examined, tested and certified.
- C. Where no specific indication as to the type or quality of material or equipment is indicated, a standard item or system shall be furnished with all options, features and capabilities to meet the project requirements.
- D. Performance and Capacity:
  - 1. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance. In some cases equipment may be sized to allow for future requirements or for other reasons which may not be stated on the Drawings or in the Specifications; provide equipment and systems with the capacities, capabilities and features indicated to provide the maximum or minimum (as appropriate) conditions.
- E. Operating conditions and capacities must be as follows:
  - 1. No overloading.
  - 2. No operation at conditions outside of maximum and minimum limits recommended by the manufacturer and accepted by the Architect/Engineer.
  - 3. Compatible with all systems.
- F. Unless otherwise specified, all equipment and materials furnished must be as follows:
  - 1. Recommended by the manufacturer for the application.
  - 2. Installed in accordance with the manufacturer's recommendations for the application except where specifications and drawings clearly indicate otherwise.

2.2 ACCESS DOORS AND PANELS

- A. Locations: Provide access doors and panels (access units) as necessary for access to items which are concealed and which may require service or maintenance or other reason for accessibility. Examples of such items include, but are not limited to, the following: valves, cleanouts, pipe unions, expansion joints and connectors, dampers, coils, junction boxes, duct heaters, terminal units, HVAC control system devices and similar types of items.
- B. Access units: Shall be manufactured by the Milcor Division of Inland-Ryerson, Boico, Nystrom or Ventfabrics. Types are as follows (Milcor style designations are used for example only):

<u>Location</u>	<u>Door/Panel Type</u>
Drywall	Style "DW"
Masonry or tile	Style "M-stainless"
Acoustical tile	Style "AT"
Plaster	Style "K"
Fire-rated walls	Style "Fire Rated"***
(**or as indicated below)	

- C. Fire Rated Units:
  - 1. Frame and panel assembly shall bear a U.L. label reading, "frame and door assembly, rating 1-1/2-hour (B), temperature rise 30 minutes 250°F maximum".
  - 2. Have an automatic closing device and mechanism to release the latch bolt from the inside.
  - 3. Acceptable Manufacturers: Boico Style F, Inryco/Milcor Style VA, Nystrom Style APFR.
- D. Non-fire Rated Units:
  - 1. Steel panels and frames.
  - 2. Locks and latches shall be as appropriate for the location and shall be cam-lock type latches, flush screw driver operated locks or cylindrical locks.
  - 3. Provide two keys for all doors. All doors shall be keyed the same.
- E. Other Requirements:
  - 1. Doors and panels installed in glazed or ceramic tiled surfaces, in toilet rooms or in kitchens shall be stainless steel.
  - 2. Unless otherwise indicated, finish shall be rust inhibitive prime coat.
- F. Sizes:
  - 1. Minimum size: 8" x 8".
  - 2. Sizes of each unit shall be individually selected to allow the recommended and required service and maintenance and accessibility functions to be accomplished. These functions shall generally include, for example, valve removal, damper linkage resetting, control adjustment, lubrication, repair, replacement and similar tasks as may be necessary and recommended for the concealed item.
  - 3. Sizes shall be of the following increments (unless otherwise approved) to allow the accessibility function to be accomplished: 8" x 8", 8" x 12", 12" x 12", 12" x 16", 16" x 16", 16" x 24", 24" x 24", 24" x 36", 30" x 30", 36" x 36" or 36" x 48".
  - 4. No size smaller than 16" x 24" shall be allowed when a person must pass through the access opening in order to accomplish the desired accessibility function.
  - 5. Every attic or furred space in which mechanical equipment is installed shall be accessible by an opening and passageway as large as the largest piece of the equipment and in no case less than 22 x 36 inches continuous from the opening to the equipment and its controls. The opening to the passageway shall be located not more than 20 feet from the equipment measured along the center line of such passageway.

2.3 PAINTING AND MARKING

- A. All paint and materials used for painting shall be manufacturer's "first quality" product. For additional paint material requirements, refer to Section 09 91 01, Painting.
- B. Marking: Refer also to sections describing identification of mechanical systems.

2.4 PIPE HANGERS AND SUPPORTING DEVICES

- A. General: Refer to other sections of Division 23 for any requirements which may be additional to this section. Comply with the more stringent requirement if more than one method is specified or shown.

- B. Pipe supporting devices specified herein shall apply to all Division 23 piping unless modified in subsequent sections of Division 23 (i.e., vibration isolation) or detailed on the drawings.
  - 1. Pipe hangers for copper pipe shall be copper or copperplated and for steel pipe shall be zinc-plated, clevis type hangers.
  - 2. Hangers for pressure piping shall be clevis type or accepted as equivalent. Pipe hangers shall be capable of vertical adjustment after erection of the piping. Piping shall not be hung from fire and/or smoke walls.
  - 3. Vertical piping supports shall be constructed of carbon steel with rounded ears and two or four holes for clamping bolts. Steel, galvanized and cast iron piping riser clamps shall have galvanized finish. Copper and brass piping riser clamps shall have electro-plated copper or PVC coating finish.
  - 4. Acceptable Manufacturers are Grinnell, PHD Manufacturing Inc., Fee and Mason, Michigan and Elcen.
- C. Beam clamps may be used when supporting piping from steel structures.
- D. Concrete inserts shall be placed in forms as work of Division 23 prior to the time that concrete is poured.
- E. Lead tamp-ins may be used when installed in a concrete or masonry wall or other like vertical surface to support a vertical hanger. Lead tamp-ins will not be permitted to support hangers to the underside of a concrete slab.
- F. For parallel runs of above ground suspended piping, an acceptable trapeze-type hanger may be used. Provide permanent, non-conductive type wrapping between copper pipe and steel trapeze hangers.
- G. Powder set type fasteners or inserts shall not be used.

## 2.5 FLOOR, WALL OR CEILING PLATES OR ESCUTCHEONS IN EXPOSED AREAS

- A. Shall be chrome-plated. Escutcheons for extended sleeves shall be of the type designed for that purpose. Split ring escutcheons will not be allowed.
- B. Escutcheons to be as manufactured by Guarantee Specialty Mfg. Co., Cleveland, Ohio; American Sanitary Mfg. Co., Abingdon, Ill., or Beaton Cadwell.
- C. Provide escutcheons or fabricated plates or collars at each location where pipe or duct passes through a finished surface. Escutcheons for flush sleeves shall be equivalent to Benton & Caldwell No. 3A chromium plated brass; for sleeves extending above floor shall be equivalent to Benton & Caldwell No. 36 chrome plated brass. Collars or plates for ducts and large diameter insulated pipe shall be fabricated of 18 gage galvanized copper bearing sheet steel, secured to structure and neatly fitted around duct or pipe.

## 2.6 SLEEVES

- A. General: Lay out work and set sleeves in new or existing construction so that minimum cutting, drilling and patching is required. Seal all sleeves not used during construction period with grout. Seal unused penetrations and sleeves through fire rated barriers to prevent passage of smoke and heat using an Underwriters' Laboratories approved method; sealing method must be rated at least equivalent to the barrier being penetrated. Submit proposed method to show proof of UL approval.
- B. Pipe Sleeves, Special Considerations: The following conditions require pipe sleeves as indicated:
  - 1. Where subject to hydrostatic pressure: Sleeves installed in walls and floors subject to hydrostatic (water) pressures shall be "Link Seal" (Thunderline Corp) Type WS or accepted as equivalent.
  - 2. Where piping is existing: When fire rated walls are to be erected where there is existing piping, provide Proset fire rated split wall system pipe sleeves, or accepted equivalent.
  - 3. Where penetration is part of air duct or plenum system: Do not use plastic pipe for sleeves where floor being penetrated is part of an air plenum so that no fire or smoke hazard is introduced by use of plastic.
  - 4. Where penetration is through fire rated barriers: Provide mild steel sleeves for penetrations of fire rated barriers.
- C. Pipe Sleeves in Walls and Partitions:
  - 1. Sleeves Above Grade: Use schedule 40 mild steel pipe or schedule 80 CPVC pipe. Provide sleeves built into wall, partition or beam of size to allow penetration by carrier pipe and insulation covering with not less than 1/4 inch minimum clear space between outer surface of carrier pipe covering (or carrier pipe surface if no covering is provided) and inner surface of sleeve.

2. Sleeves Below Grade in Exterior Walls: Schedule 40 steel hot dipped galvanized after fabrication or cast iron sleeve with not less than 1/4-inch x 3-inch center flange (water stop) around the exterior face of the wall.
  3. Penetrations of fire rated barriers shall have only mild steel sleeves; plastic is not allowed.
- D. Pipe Sleeves in Floors Above Grade: Use schedule 40 mild steel pipe or schedule 80 CPVC pipe. Provide sleeves built into wall, partition or beam of size to allow penetration by carrier pipe and insulation covering with not less than 1/4 inch minimum clear space between outer surface of carrier pipe covering (or carrier pipe surface if no covering is provided) and inner surface of sleeve. Set sleeves before floor is poured; extend not less than 1/2-inch above finished floor.
- E. Pipe Sleeves in Floors on Grade: Sleeves shall be Schedule 40 steel or Schedule 80 CPVC plastic. Set sleeves before floor is poured. Size sleeves to allow penetration by carrier pipe and insulation covering with not less than 1/4 inch minimum clear space between outer surface of carrier pipe covering (or carrier pipe surface if no covering is provided) and inner surface of sleeve. Extend sleeve not less than 1/2 inch above finished floor.
- F. Duct Sleeves: Sleeves or openings sized to pass mechanical ducts and covering shall be of framed steel construction in roof, wall, and partitions.
- G. Sealing of Sleeves:
1. Pipe Sleeves Below Grade and On Grade: Caulk annular space between pipe and sleeve using approved caulking material to a minimum one inch deep. Result shall be a water tight and vermin proof penetration.
  2. Pipe and Duct Sleeves Above Grade: Openings around pipes, ducts and other conduit passing through sleeves shall be made draft free and vermin-proof by solidly packing with mineral wool or fiberglass or by other such approved method.
  3. Pipe and Duct Sleeves Through Fire Rated Barriers: All penetrations through fire rated barriers (both walls and floors) shall comply with Division-07 or be as specified in this Division.

## 2.7 FIRE AND/OR SMOKE RATED FLOOR, PARTITION OR WALL PENETRATION SEALANT

- A. Seal shall be composed of fire barrier product, putty, or caulking materials used either in combination or singularly. Acceptable Manufacturers are 3M Corporation or Dow Corning.
- B. All sealing of floor, partition or wall systems shall be in accordance of the requirements of the associated tested assembly (i.e. UL, USG). Coordinate assembly requirements with architectural drawings and specifications.

## 2.8 EXCAVATION AND BACKFILL

- A. Provide as necessary to accomplish work specified. Perform in accordance with applicable State and Local codes and accepted good practice and in accordance with other applicable sections or divisions.

## 2.9 BELT DRIVES

- A. General: Equip each motor driven machine not direct connected with V-belt drive. Belts shall be of correct cross section to fit properly in sheave grooves and shall be carefully matched for each drive. Sheaves shall be cast iron or steel, bored to fit properly on shafts and secured with keys of proper size. The rating of each drive shall be as recommended by manufacturer for service but shall be at least 1.5 times nameplate rating of motor.
- B. Speed Adjustment: Adjust fan speed by change(s) in sheave size as necessary to obtain proper design air flow with fan in its installed location. Fans may be first fitted with variable pitch drives until proper speed adjustment is made and then fitted with proper fixed pitch drive size, or alternate sizes of fixed pitch drives may be used until proper fan needed to deliver necessary air quantity.
- C. Vibration of Air Handling Equipment and Fan Units: For air handling equipment and fans driven by motors 5-hp or greater, field vibration levels will not be acceptable if the maximum vibration velocity or displacement measurement exceeds the following values (when measurements are taken at the bearing supports using a vibration analyzer with the filter set at the operating fan speed):



<u>Fan Speed (RPM)</u>	<u>Maximum Vibration Level</u>
800 or Less	5 Mils (0.127 mm) max. displacement
801 and Greater	0.20 in/sec. (5 mm/s) max. velocity

- D. Belt and Coupling Guards: Each belt drive shall be equipped with an OSHA approved guard. Guards shall be constructed of #12 U.S. standard gage 3/4-inch diamond mesh wire screen, or equivalent, welded to one inch steel angle frames, and shall enclose all belts and sheaves. Tops and bottoms of guards shall be of substantial sheet metal or not less than #18 U.S. standard gage. Braces or supports must not "bridge" sound and vibration isolators. Guards shall be designed with adequate provision for movement of motor required to adjust belt tension. Means shall also be provided to permit oiling, use of speed counters, and other maintenance and testing operations with guard in place. All direct drive equipment shall have coupling guards in accordance with Florida Department of Business Regulation safety regulations and OSHA.

## 2.10 BEARINGS

- A. All bearings shall be 200,000-hour rated unless otherwise specified.

## PART 3 - EXECUTION

### 3.1 EQUIPMENT ACCESS

- A. Access Doors and Panels:
- Locations: Provide access unit at the following locations.
    - Where additionally specified in other sections of this Divisions 22 and 23 and where specifically indicated on the drawings.
    - Where not specifically indicated on the drawings but where the work to be provided will require accessibility for purposes as described or as recommended by the manufacturer of the concealed item.
    - At all locations where concealed equipment, fixtures, devices and similar items require accessibility for service, inspection, maintenance, repair, replacement and where such concealed item would not otherwise be accessible for such functions without the provision of an appropriately sized access unit.
- B. Installation:
- Definitions: For the purpose of coordination of responsibility, the following words are defined to describe the intended coordination.
    - "Furnish" means to procure an item and deliver it to the project for installation.
    - "Install" means to determine (in coordination with others as necessary) the intended appropriate location of an item and to set, connect and otherwise fix in place in a manner to allow intended operation and use.
    - "Provide" means to both furnish and install fully and completely in all aspects.
  - Furnishing Access Units: Access units shall be furnished as work of the Division which governs the item which is intended to be made accessible by the access unit.
  - Installing Access Units: Access units shall be installed as work of the Division which governs the surface, barrier, partition or other building component in and on which the access unit is to be placed.
  - Determination of Locations:
    - Where the work of Division 23 requires that the access unit be provided (i.e., both furnished and installed), then the responsibility for determination of the location at which the access unit is to be placed is also work of Divisions 23.
  - Determination of Sizes:
    - Unless an access unit size is indicated on the drawings or otherwise specified, the size of each access unit shall be determined as work of the Division which either provides or furnishes the access unit.
    - Sizes for access units which are provided or furnished as work of this Division shall be in compliance with sizing criteria of this Division.

### 3.2 PAINTING

- A. Paint all exposed piping, insulation, equipment, structural bases, racks, in equipment rooms and on roof, furnished under Division 23 of these specifications. All exposed metal surfaces shall be given one prime coat and two finish coats. All insulated surfaces shall be given one sizing coat of glue sizing (omit this step if factory applied finish is suitable to receive prime coat), one prime coat and one finish coat. Factory painted or finished items do not require field painting but shall require "touch-up" with matching paint or finish where scratched.
- B. Pipe hangers, saddles, supports, riser clamps and accessories shall be painted to match their piping.
- C. Equipment not completely accessible for painting when set in place shall be thoroughly cleaned and painted before installation and suitably protected.
- D. Piping concealed or provided with aluminum or PVC jacketing need not be painted.

### 3.3 HANGERS AND INSERTS

- A. Refer also to other sections which may describe additional requirements for hanging and supporting. Comply with the more stringent requirement if more than one method is specified or shown.
- B. Provide and properly locate hangers to adequately support piping and equipment. Arrange hangers to permit expansion and contraction.
- C. The size of hanger for non-insulated pipes shall be suitable for pipe size to be supported. For insulated piping, the size of the hanger shall be suitable for the pipe size, plus the insulation and a 16-gauge half-circle galvanized sheet metal insulation saddle.
- D. Isolation of copper pipe from steel hangers to consist of wrapping pipe at, and 1" each side of contact surface with not less than two layers of adhesive type plastic electrical insulating tape.
- E. Pipe supports for piping 2" diameter and below may be supported directly from Epicure steel decking using Epicure standard hangers (200 lb. max. load). Piping above 2" shall be supported from steel beams.
- F. Locate pipe supports as follows unless noted in other sections of these specifications or on the drawings:
  - 1. Horizontal cast iron pipe inside building - supported on each length of pipe.
  - 2. Vertical cast iron pipe inside building - supported at each floor level and at the base.
  - 3. Horizontal steel piping and copper tubing 1" diameter and under - support on 6' centers.
  - 4. Horizontal steel piping and copper tubing above 1" through 1-1/2" diameter - support on 8' centers.
  - 5. Horizontal steel piping and copper tubing larger than 1-1/2" diameter -support on 10' centers, except 24" diameter piping shall be supported by main roof beams (20' O.C. maximum).
  - 6. Support vertical cast iron, steel and copper piping at each floor penetration not to exceed 20 foot intervals.

### 3.4 ANCHORS

- A. Install a suitable anchor on piping to prevent movement from expansion and contraction by welding or clamping securely to pipe at fitting or coupling. Approval of the Architect/Engineer of method of anchorage must be obtained before installation of work. Properly anchor piping to remove strains on equipment which would be caused by expansion and contraction. Adequately insulate anchors on piping, with operating fluid temperatures below 75°F, to prevent moisture condensation problems.

### 3.5 EXPANSION AND CONTRACTION PROVISIONS

- A. Piping is designed with offsets and loops to provide for expansion and contraction. At such points, piping shall be cold sprung to equalize expansion when at operating temperatures. Install piping to maintain grade at all operating temperatures.

### 3.6 FLASHING

- A. Flashing shall be done as work of other divisions.

3.7 SLEEVES FOR PIPING

- A. Provide sleeves for all piping where pipe penetrations in walls, floors or other building structure are required. Sleeves in poured concrete shall have watertight seams and joints.
- B. Extend sleeves through walls, partitions and ceilings to finished surface. Extend sleeves through finished floors to not less than 1/4 inch above finished surface. Extend sleeves in concrete floors in chases to not less than 1 inch above floor top surface. Sleeves installed above finished ceilings as part of fire/smoke rated wall assemblies shall extend not less than 1" beyond both wall faces.
- C. Provide sleeves of adequate size to permit clearance for pipe movement and proper grading and sloping of pipes. Provide sleeves for insulated pipe of adequate size to clear insulation.
- D. Caulk space between sleeve's inner surface and pipe's outer surface (including insulation surface if pipe is insulated) with approved with fire rated safig material. Provide flexible fire-retardant sealant if pipe is subject to expansion or contraction. Final result shall be an approved fire and smoke stop at pipe and sleeve assembly.
- E. Sleeves in walls and slabs subject to hydrostatic pressures shall be water tight at twice the hydrostatic pressure expected to be encountered at the location of the penetration.

3.8 SLEEVES FOR DUCTWORK

- A. Ductwork sleeves shall be provided in accord with current SMACNA recommendations or as otherwise detailed on Drawings. Refer also section describing duct systems.

3.9 ESCUTCHEONS

- A. Provide chrome plated brass escutcheons (for 1/4 or 1 inch projecting sleeves as required) at each point where an uninsulated pipe passes thru a finished surface.

3.10 CONCRETE BASES AND STRUCTURAL STEEL

- A. Concrete bases and structural steel to support equipment and piping installed under each specification section or Division 23 and not specifically shown on the structural or architectural plans shall be included and provided for this work.

3.11 SEALANT

- A. Fire/smoke sealant shall be installed in strict compliance with the manufacturer's installation instructions.

END OF SECTION

**SECTION 23 05 13**

**ELECTRIC MOTORS, PREMIUM EFFICIENCY TYPE**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.
- B. Division 26 – Electrical.

1.2 SCOPE

- A. This Section describes electric motors which are higher efficiency. These motors require less energy than standard electric motors which do not meet this specification.
- B. This specification covers 3/4 HP or larger horizontal, 3 phase, integral horsepower, drip proof, squirrel cage induction motors in the NEMA frame sizes through 449.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.

1.4 STANDARDS

- A. All motors shall be in accordance with the latest version of NEMA Standard MG-1. Motors shall also comply with the applicable portions of the National Electric Code.

1.5 SUBMITTALS

- A. Independent motor submittals for motors that are part of air handling unit or pumping equipment shall be provided for all motors 1 HP or greater.

**PART 2 - PRODUCTS**

2.1 VOLTAGE FREQUENCY

- A. Motors through 100 hp shall be rated 230/460 volts with 200 or 575 volts as optional; motors above 100 hp shall be rated 460 volts with 575 volts as optional. Motors will be rated for operation on a 3 phase, 60 Hertz power supply. Refer to Electrical Drawings.

2.2 COORDINATION

- A. Where variable frequency drives are used to vary the speed and power consumption of electric motors, such motors must be high efficiency type and must be considered with the actual variable frequency drives which are provided so that optimum matching of variable frequency drive to driven motor is obtained.

2.3 OPERATING CHARACTERISTICS

- A. Torques: Motors shall meet or exceed the locked rotor (starting) and minimum breakdown torques specified in NEMA standards for Design B for the ratings specified.
- B. Currents: Locked rotor (starting) currents shall not exceed NEMA Design B maximum values for the specified rating. Motors shall be capable of a 20 second stall at six times full load current without injurious heating to the motor components.
- C. Efficiency: Motors shall have full load efficiency which will meet or exceed the values for NEMA Premium® efficiency motors as listed in NEMA 1-2006, Table 12-12 when tested in accordance with NEMA test

standard MG1-12.53a, IEEE Test Procedure 112, Method B, using accuracy improvement by segregated loss determination including stray load loss measurements. The minimum efficiency shall be guaranteed.

2.4 SERVICE FACTOR AND AMBIENT

- A. Motors shall be rated for a 1.15 service factor in a 40°C ambient.

2.5 INSULATION

- A. For constant speed application motors, provide full Class B insulation system.
- B. For motors with variable frequency drive, provide with Class F insulation suitable for operation down to 10%.

2.6 FRAME SIZE

- A. Horsepower/frame relationship shall conform to the latest NEMA Standard for T frame motors.

2.7 ENCLOSURE

- A. Motors shall be drip proof construction.
- B. Motor frame and endshields shall be of cast aluminum construction using alloys with low copper content.

2.8 BEARINGS

- A. All motors shall have anti-friction bearings, sized for a L-10 life of at least 125,000 hours L-10 life for a direct connected load.
- B. Aluminum endshields shall have a cast-in steel or cast iron bearing insert.
- C. Bearing housing shall be regreasable with provisions for purging old grease.
- D. Bearings shall be preloaded with a bearing loading spring to minimize noise and increase bearing life.

2.9 OTHER REQUIREMENTS

- A. Conduit Box shall be diagonally split and rotatable in 90 degree increments.
- B. External hardware shall be plated to resist corrosion.
- C. External paint shall withstand industrial environments.
- D. Nameplates shall be of stainless steel or aluminum and stamped per NEMA Standard MG1-10.37. Nameplate information shall include the nominal efficiency value per Standard MG1-12.53b and the manufacturer's minimum guaranteed efficiency value.

2.10 SHOP DRAWINGS

- A. In addition to shop drawing requirements of the section entitled, "General Mechanical Provisions", provide motor data including horsepower; rpm; frame size; nominal efficiency and nominal power factor at full load, 75% load and 50% load; guaranteed efficiency and guaranteed power factor at full load, 75% load and 50% load.

**PART 3 - EXECUTION**

3.1 MOTOR LOCATIONS

- A. Provide NEMA Premium® efficiency motors for the following as provided on this project:
  - 1. All motors of 3/4 HP and above for all Division 23 motors.

END OF SECTION

**SECTION 23 05 15**

**INSTRUCTIONS AND MAINTENANCE MANUALS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide complete written and verbal operating and maintenance instruction to the Owner for all mechanical systems.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Divisions 22 and 23 and to all other applicable portions of the Drawings and Specifications.
- B. This section directly relates in particular to sections which describe the following:
  - 1. Valves and piping systems components requiring maintenance and which are involved in the dynamic function of the systems.
  - 2. Pumps and related flow devices.
  - 3. Plumbing equipment (heat exchangers, packaged systems, etc.)
  - 4. HVAC equipment (all air handling equipment, terminal units, filter assemblies, etc).
  - 5. Control systems.

**PART 2 - PRODUCTS**

2.1 INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Provide three Instructions and Maintenance Manuals, each complete as follows:
  - 1. Hardback three-ring loose-leaf binders.
  - 2. Title sheet with job name, Contractor's, subcontractor's control subcontractor and related contractor's or material supplier's names, addresses and phone numbers.
  - 3. Index of contents.
  - 4. A signed copy of acknowledgment of instructions to the Owner or his authorized representative. Two additional copies of the signed acknowledgment shall be sent directly to the Architect as soon as possible after receipt.
  - 5. Typewritten operating instructions for the Owner's personnel describing the following for each piece of equipment and systems:
    - a. How to start and stop each piece of equipment.
    - b. How to set equipment and systems for normal operation.
    - c. Normal restarting procedures before contacting the service contractor.
    - d. Complete description of functions and operations of each piece of equipment including description of how equipment operates in conjunction with automatic control systems.
    - e. Instructions for cleaning, oiling, greasing, fueling and similar tasks.
  - 6. Approved shop drawings and submittal data and parts and maintenance booklet for each item of material and equipment furnished under this Division, including (but not limited to) the following:
    - a. Spare parts list and source of supply for each equipment item.
    - b. List of valves with location, service, size, model and operating position.
    - c. Diagrams clearly indicating automatic control hook-up.
  - 7. Any as-built wiring diagrams as called for in other sections of this division as needed to show how equipment controls interface with related systems.
  - 8. Copies of certificates of inspection.
  - 9. Guarantees.
- B. Electronic versions of all instruction and maintenance manuals shall also be provided in PDF form on a thumb drive.

1. All files shall be organized in a folder structure.
2. Folders shall be named with the applicable specification section and title.
3. File names shall begin with a description of the content (i.e. O&M, Warranty, Shop Drawing, etc.) and then include the description of the equipment or material for which the document applies.

### **PART 3 - EXECUTION**

#### **3.1 VERBAL INSTRUCTION**

- A. Provide verbal, hands-on, operating and maintenance instruction to Owner's authorized personnel for each equipment item and system. Instruction shall be given by competent personnel.
  1. Duration: Total instruction period for all systems of this Divisions 22 and 23 shall be not less than fifteen (15) working days. The Owner reserves the right to audio-tape or video-tape the instruction procedure.

#### **3.2 MANUFACTURERS' SERVICE REPRESENTATIVES**

- A. Verbal instruction at the site for the following equipment items and systems shall be given jointly by the contractor and the authorized manufacturer's service representative. (Contractor and manufacturer's service representative shall provide instruction to Owner for each equipment item of no less duration than the hours indicated in parenthesis. Duration shall be greater if otherwise specified).
  1. Air Handling Units. (48 hours)
  2. Exhaust Fans. (24 hours)
  3. Controls – Refer to 23 09 23 for requirements.

END OF SECTION

**SECTION 23 05 16**

**HOUSEKEEPING PADS, CONCRETE**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide concrete housekeeping pads for the equipment listed in this section. This work shall be performed by the concrete installer.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Divisions 22 and 23 and to all other applicable portions of the drawings and specifications.
- B. This section directly related in particular to sections (which may or may not be included in this division) which describe the following:
  - 1. Concrete described in other divisions.

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. All concrete and steel for concrete housekeeping pads shall comply with those sections of the specification division describing concrete and steel.

2.2 HOUSEKEEPING PADS

- A. Provide reinforced (#4's @ 12" both ways with 1-1/2" top cover) concrete housekeeping pads for each individual machine. Pads shall extend six inches beyond the machine bases in all directions and be continuous beneath the machine. Pads shall have chamfered edges and shall be poured and finished smooth and level to insure proper and continuous support for the bearing surfaces of the machine.
- B. Coordinate exact length and width of each pad and any penetrations which may be necessary for piping or conduit with the actual equipment approved for use on the project.

**PART 3 - EXECUTION**

3.1 GENERAL

- A. Refer to the section describing vibration isolation for equipment which is to rest on concrete housekeeping pads.

3.2 PAD HEIGHTS

- A. Provide 6" high concrete pads for the following:
  - 1. All equipment specified or shown to be on a concrete pad if no height is given.
  - 2. Indoor air handling units.
  - 3. Domestic water heaters.

END OF SECTION



**SECTION 23 05 18**

**PIPING: CONDENSATE DRAIN**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide condensate drain piping from cooling coil drain pans.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.
- B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:
  - 1. Air handling equipment with cooling coils.
  - 2. Insulation.

1.4 SHOP DRAWINGS

- A. Refer to Section entitled "General Mechanical Provisions".

**PART 2 - PRODUCTS**

2.1 PIPE

- A. Type M hard drawn copper conforming to ASTM Spec. B88.

2.2 FITTINGS

- A. Wrought copper, solder joint, pressure type conforming to ANSI B16.22.

2.3 SOLDER

- A. Composition SB5 (95/5), Fed. Spec. QQ-S-571d and Class 3 (Sil Fos), Fed. Spec. AA-S-561d, ASTM B32.

**PART 3 - EXECUTION**

3.1 GENERAL

- A. Piping shall be sloped uniformly toward drain, and provided with trap seal having a depth, in inches, equivalent to one and one-half (1-1/2) times the total static pressure of the respective fan system. Traps shall be assembled using elbows and tees with threaded brass plugs to permit cleaning of trap and drain line. Piping shall be installed in a neat manner and shall be not smaller than full size of the equipment drain connection or three-quarters inch (3/4") whichever is larger.

3.2 JOINTS AND CONNECTIONS

- A. General: Joints and connections shall be made permanently air, gas, and water tight.
- B. Solder Joints: Cut pipe square using cutting tool which does not crimp pipe. Remove all burrs using pipe reamer and taking care not to flare the pipe end. Thoroughly clean the outside of pipe and the interior of the fittings using a fine sand cloth. Apply noncorrosive paste flux to the cleaned surfaces immediately and apply solder and heat, in accordance with manufacturer's instructions, to complete joint.

- C. Equipment Connections: Connections to copper drain nipples may be made with solder joints provided care is exercised not to damage equipment, its insulation or finish. Connections to equipment having steel nipples shall be made using screwed to solder adapters with teflon tape applied to male threads prior to assembly.

### 3.3 ROUTING

- A. Unless otherwise indicated, route pipe discharge as follows:
  - 1. Interior Equipment: To nearest floor drain.

### 3.4 INSULATION

- A. Insulate if so specified in section describing insulation.

END OF SECTION

**SECTION 23 05 29**

**HANGERS AND SUPPORTS**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

- A. Provide all angles, brackets, clamps, anchors, inserts, rods, braces, frames, hangers nuts and bolts, and other miscellaneous steel and hardware items as may be required for the proper support of equipment, piping systems, HVAC systems, plumbing systems and fire protection systems.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Divisions 22 and 23 and to all other applicable portions of the Drawings and Specifications.
- B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:
  - 1. Piping systems.
  - 2. Duct systems.
  - 3. Equipment items.

1.4 SHOP DRAWINGS

- A. Refer to Section entitled "General Mechanical Provisions". Provide specific data on hangers, stands, clamps, rollers, guides, shields, anchors and their proposed application. Submit detailed shop drawings, showing method of support and anchoring for all piping and equipment as follows:
  - 1. Piping Systems:
  - 2. Scaled single line piping plans superimposed on structural construction drawings. Scale shall be minimum 1/4" = 1'-0". Piping which is three inch (3") diameter and smaller may be omitted from these shop drawings. Drawings shall clearly indicate the location and type of each and every insert, hanger, stand, support, guide, isolator and anchor; and shall also indicate the size, type locations and method of attachment for all miscellaneous structural steel required.
  - 3. Sectional drawings, sketches and other details as may be required to clearly communicate the method of support, anchoring, guiding and vibration isolation.
  - 4. Show details of any typical floor or wall penetrations including: riser clamp, pipe sleeve, and provisions for water stop to prevent the water travel between penetrations.

1.5 INDUSTRY STANDARDS

- A. Where compliance with an industry, society or association standard is specified or indicated, certification of such compliance shall be submitted with shop drawings.

1.6 MANUFACTURER

- A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:
  - 1. F&S Manufacturing Corp.
  - 2. Fee and Mason Manufacturing Co.

**PART 2 - PRODUCTS**

2.1 HANGERS

- A. Hangers In Contact With Copper Piping: Shall be copper plated or teflon coated. Hangers shall be Fed. Spec. WW-H-171E, Type 9. Acceptable: Grinnell Fig. 97 or 97C, or equivalent.

- B. Hangers (other than in Contact with Copper Piping): Shall have manufacturer's standard finish. Hangers shall be of the following types:
  - 1. Pipe 3" and Larger: Fed. Spec. WW-H-171E, Type 1. Acceptable: Grinnell Fig. 260 or equivalent.
  - 2. Pipe 2-1/2" and Smaller: Fed. Spec. WW-172E, Type 6. Acceptable: Grinnell Fig. 104 or equivalent.

## 2.2 ISOLATORS

- A. Refer to the Section, if included in this Division, which describes vibration isolation.

## 2.3 PIPE ROLLER STANDS

- A. Shall be Fed. Spec. WW-H-171D, Type 47. Acceptable: Grinnell Fig. 171, or equivalent.

## 2.4 PIPE ROLLER HANGERS

- A. Pipe Roller Hangers: Shall be Fed. Spec. WW-H-171E, Type 42. Acceptable: Grinnell Fig. 171, or equivalent.

## 2.5 PIPE ALIGNMENT GUIDES

- A. Acceptable: Grinnell Fig. 256, or equivalent.

## 2.6 PIPE RISER CLAMPS

- A. Pipe Riser Clamps: Shall be Fed. Spec. WW-H-171D, Type 8.

## 2.7 INSULATION SHIELDS

- A. Shall be Fed. Spec. WW-H-171D, Type 41. Acceptable: Grinnell Fig. 167, or equivalent.

## 2.8 BEAM CLAMPS

- A. Fed. Spec. WW-H-171D, Type 29. Acceptable: Grinnell Fig. 292 with links, or equivalent.

## 2.9 INSERTS

- A. Preset Type: Malleable iron with removable interchangeable nuts having lateral adjustment of not less than one and five-eighths inches. Continuous inserts shall have a capacity of 2,000 lb. per foot and shall be hooked over reinforcing. Acceptable: C-B Universal Fig. 282; Unistrut Products Co., P3200 or P3300; B-Line Systems, Inc., Series B- 32.1, or equivalent.

## 2.10 ROD

- A. Carbon steel, black threaded bolt ends or continuous thread, sized with safety factor of five (5). Acceptable: Grinnell Fig. 140 or 146, or equivalent.

## **PART 3 - EXECUTION**

### 3.1 GENERAL

- A. Refer to Section entitled "General Mechanical Provisions". All inserts, fasteners, hangers and supports shall be installed in strict accordance with manufacturer's instructions.

### 3.2 PIPE

- A. General: Hangers shall be spaced to prevent sag and to permit proper drainage. All piping shall be run parallel with the lines of building, unless otherwise indicated on drawings. The hanger spacing and placement shall be such that after the covering (insulation and finish) is applied, there will be not less than 1/2" clear space between finished covering and other surfaces, including the finished covering of parallel adjacent pipes. Hangers for insulated pipes shall be sized to encompass the insulation, finish and metal insulation shield (a metal insulation shield shall be provided for each hanger or support). Vertical piping shall be supported with pipe riser clamps at every floor penetration, unless specifically indicated otherwise on the drawings. Hangers and supports shall not be placed at greater than the following intervals:

1. Pipe 1" and Smaller: Eight foot (8') centers and not more than two feet (2') from a change in direction (offsets, elbows, and tees).
2. Pipe 1-1/4" through 2-1/2": Ten foot (10') centers and not more than two feet (2') from a change in direction (offsets, elbows and tees).
3. Pipe 3" and Larger: Fourteen foot (14') centers and not more than two feet (2') from a change in direction (offsets, elbows, and tees).

3.3 EQUIPMENT

- A. Equipment supports shall be as otherwise indicated on the drawings or in the specifications.

3.4 DUCTWORK

- A. Refer to Sections describing ductwork.

3.5 POWDER (GUNPOWDER) ACTUATED FASTENERS

- A. Not allowed.

3.6 STEEL DECKING

- A. On projects where floor or roof slabs are installed over steel decking, drill or punch web of steel decking and insert hangers with washers before the concrete fill is poured in place. Hangers shall be plumb within one-half inch (1/2") in four feet (4') and spaced as required for service intended.

END OF SECTION

**SECTION 23 05 48**

**VIBRATION ISOLATION EQUIPMENT**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide vibration isolation supports for all equipment and piping as may be required to prevent transmission of vibration to building structure. This shall include air handling units, fans, piping, pumps and similar items.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the drawings and specifications.

1.4 SHOP DRAWINGS

- A. Refer to Section entitled "General Mechanical Provisions". Submittal data shall show type, point loading information, size and deflection of each isolator proposed and any other information as may be required for the Architect/Engineer to check isolator selections for compliance with specifications. Include clearly outlined procedures for installing and adjusting the isolators.

1.5 MANUFACTURERS

- A. Products of the following manufacturers will be acceptable, provided they comply with all of the requirements of this specification: Consolidated Kinetics; Mason Industries; Amber-Booth; Keflex; Flexonics; Vibration Eliminator Company or equivalent. Any model numbers listed are from one or more of these manufacturers and are given to provide an example of item(s) required.

1.6 OTHER REQUIREMENTS

- A. All vibration isolation equipment shall be both recommended by the manufacturer and approved by the Architect/Engineer for each particular application on this project.

**PART 2 - PRODUCTS**

2.1 BASIC REQUIREMENTS

- A. Unless otherwise noted, spring type vibration isolators shall be used for all motor driven equipment. It shall be the responsibility of isolation manufacturer to determine the amount of spring deflection required for each isolator to achieve optimum performance, prevent the transmission of objectionable vibration and meet noise criteria referenced herein.

2.2 CORROSION PROTECTION

- A. Steel components shall be phosphated and painted. All nuts, bolts and washers shall be zinc-electroplated. Structural steel bases shall be thoroughly cleaned of welded slag and primed with zinc-chromate or metal etching primer.
- B. All isolators exposed to weather shall have steel parts PVC coated or hot-dip galvanized. Aluminum components shall be etched and painted. Nuts, bolts and washers may be zinc-electroplated.

2.3 BASIC ISOLATORS

- A. General: Unit designations indicated are Architect/Engineer designations. Each of the following basic isolators may not be applicable to a specific installation application. See PART 3, "EXECUTION".

- B. Spring Mounts, Open Type, Unrestrained (Unit SMOU): Free standing springs; laterally stable; minimum horizontal-to-vertical spring rate ( $K_x/K_y$ ) of 1.0: 1/2-inch neoprene acoustical friction pads between bottom baseplate and the supporting surface; leveling bolts; provision for bolting the mount to the equipment (unless otherwise specified); spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; 1-inch minimum static deflection (unless otherwise specified); submittals shall include spring diameters, deflections, free spring heights, solid spring heights and operating heights. Be similar to Mason Type SLF; Korfund Series L; Amber-Booth Type SW.
- C. Spring Mounts, Open Type, Restrained (Unit SMOR): Free standing springs; laterally stable; 1/2 inch neoprene acoustical friction pads between bottom baseplate and the supporting surface; leveling bolts; provision for bolting the mount to the equipment (unless otherwise specified); spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; 1-inch minimum static deflection (unless otherwise specified); restraint consisting of welded steel channel ends for outdoor installation and welded steel studs for indoor installation; restraint shall have restraining bolts connecting top plate and lower housing to limit vertical rise of isolated equipment when load is reduced; vertical clearance of 1/8 to 3/8 inch shall be maintained between spring top plate and housing (leveling bolts shall be adjusted to maintain this clearance). Submittal shall include spring diameters, deflections, free spring heights, solid spring heights and operating heights. Be similar to Mason Type SLR; Amber-Booth Type CT.
- D. Spring Mounts, Housed, Unrestrained (Unit SMHU): Springs free standing within their housing; laterally stable; 1/2 inch neoprene acoustical friction pads between bottom baseplate and the supporting surface; leveling bolts; provision for bolting the mount to the equipment (unless otherwise specified); spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; 1-inch minimum static deflection (unless otherwise specified); welded steel housing; vertical clearance of 1/8 to 3/8 inch shall be maintained between spring top plate and housing (leveling bolts shall be adjusted to maintain this clearance). Submittal shall include spring diameters, deflections, free spring heights, solid spring heights and operating heights. Be similar to Mason Type C.
- E. Neoprene and Spring Hangers, Vertical Deflection (Unit NSHV): Steel housing for undampened support of the spring: Provisions for attachment of hanger rods; reinforced neoprene washer and grommet to break up metal to metal contact; free standing spring; 1 inch minimum static deflection (unless otherwise specified) spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection. Submittals shall include spring diameters, solid spring heights, free spring heights, deflections, overall hanger dimensions and maximum hanger rod diameter which can be accommodated by the hanger. Be similar to Mason Type DNHS: Amber-Booth Type BSR.
- F. Neoprene and Spring Hangers, Vertical and Angular Deflection (Unit NSHVA): Shall contain a laterally stable steel spring and 0.3" reflection neoprene or fiberglass element in series. A neoprene neck shall be provided where the hanger rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mason Type 30N.
- G. Neoprene and Spring Hangers, Vertical Deflection, Position Type (Unit NSHVP): Steel housing for undampened support of the spring; provisions for attachment of hanger rods; reinforced neoprene washer and grommet to break up metal to metal contact; free standing spring; 1 inch minimum static deflection (unless otherwise specified); spring diameters not less than 0.8 of the compressed height of the spring at rated load; springs shall have a minimum additional travel to full compression of 50% of the rated deflection; be capable of holding the supported item at fixed elevation during installation with secondary adjustment to transfer the load to the spring while maintaining a fixed position; scale and pointer to indicate the deflection. Submittals shall include spring diameters, solid spring heights, free spring heights, deflections, overall hanger dimensions and maximum hanger rod diameter which can be accommodated by the hanger. Be similar to Mason Type PCDNHS: Amber-Booth Type PBS.
- H. Neoprene and Spring Hangers, Vertical and Angular Deflection, Position Type (Unit NSHVAP): Shall contain a laterally stable steel spring and 0.3" deflection neoprene or fiberglass element in series. A neoprene neck shall be provided where the hanger rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and

short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Be capable of holding the supported item at the fixed elevation during installation with secondary adjustment to transfer the load to the spring while maintaining a fixed position; scale and pointer to indicate the deflection; similar to Mason Type PC30N.

- I. Neoprene-In-Shear Hangers (Unit NH): Steel housing for undampened support of the neoprene; provisions for attachment of hanger rods; neoprene-in-shear isolator; similar to Mason Type HD, Amber-Booth Type HRD.
- J. Neoprene-In-Shear Mounts (Unit NM): Double deflection neoprene-in-shear mountings shall have a minimum static deflection of 0.35". All metal surfaces shall be neoprene-covered. The top and bottom surfaces shall be neoprene ribbed and bolt holes shall be provided in the base. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang; steel rails shall be by same manufacturer as vibration isolators and equivalent to Mason Industries Type DNR. Mounts shall be Mason Industries Type ND, Consolidated Kinetics Type RD or Vibration Mounts and Controls Series RD.
- K. Flexible Pipe Connectors: Same internal diameter as the pipe in which the connector is installed (not necessarily internal diameters of inlets or outlets of equipment).
  1. Both recommended by the manufacturer and approved by the Architect/Engineer to be suitable for handling the conveyed fluid at all conditions (maximums and minimums of temperatures, pressures, velocities, etc.) encountered for each particular application.
  2. Of proper design to absorb the combination of vibratory and/or expansion or contraction motions (lateral and/or axial and/or angular) encountered at each installation point (for example, do not use hose type where axial motion is encountered at the installation point unless so recommended by the manufacturer and approved by the Architect.
  3. Stainless steel bellows type (Unit SSB): Heavy duty steel restraining rods and spacers; laminated steel bellows; steel flanges; permit axial, lateral and angular movement; rated to withstand 180°F operating temperature and 150 psig working pressure for chilled water; 250°F operating temperature and 150 psig working pressure for heating hot water; similar to Keflex Series 151 or 301.
  4. Stainless steel hose type (Unit SSH): Rated to withstand 180°F operating temperature and 150 psig working pressure; have flanges except 2-1/2 inch and smaller sizes may have screw type fittings installed with a union at one end or with screw-on flanges at both ends; net flexible lengths shall be at least 6 pipe diameters for pipe up to 5 inch ID and not less than 36 inches for pipe 6 inch ID and greater; corrugated bellows with stainless steel wire braid restraining sheath; similar to Flexonics Type RW, RF or Series 400, Mason Type BSS, Keflex Series SSH.
- L. Acoustic Seals (Unit AS): Consist of an S-shaped molded synthetic rubber seal attached with stainless steel clamps to the pipe wall sleeves and to carrier piping. Wall sleeves shall be two pipe sizes larger than the carrier pipe and/or its insulation. Amber-Booth Type 301.
- M. Inertia Bases (Unit IB):
  1. Weigh at least 1.5 times the weight of the particular machine being supported.
  2. Rectangular welded structural channel steel perimeter frame.
  3. Reinforced concrete.
  4. Height saving support brackets.
  5. Width and length at least 6 inches beyond machine's overall width and length (if necessary, larger for pumps as required to support suction and discharge wells).
  6. Structural steel channel depth and concrete base depth shall be a minimum of 1/15th of the longest base dimension but not less than 6 inches.
  7. Forms shall include 1/2 inch (or larger if necessary) steel reinforcing bars welded in place on 6 inch centers running both ways across the width and length in a layer 1-1/2 inches above the bottom of the base. Drilled steel members with sleeves welded below the holes to receive equipment anchor bolts.
  8. Similar to Mason Type KSL Base.
- N. Steel Equipment Frames (Unit SEF): Frames shall consist of structural steel sections sized, spaced and connected to form a rigid base which will not twist, rack, deform or deflect in any manner that will negatively affect the operation of the supported equipment or the performance of the vibration isolation mounts. Frames shall be of adequate size and plan form to support basic equipment units and motors plus any associated pipe elbow or duct elbow supports and electrical control elements or other components closely related and requiring resilient support in order to prevent vibration transfer from equipment to the building structure. Frames shall include side mounting brackets for attachment to Unit



SMOU isolator or other specified isolator. The clearance between the underside of any frame or mounted equipment unit and the top of the building structure below shall be at least 2 inches.

- O. Neoprene Pads (Unit NP): Waffle or ribbed pattern neoprene pads shall be fabricated from 40-50 Durometer neoprene. Mason Type W.
- P. Isolation rails, curb mounted, for roof mounted air handling units (Unit IRCM): Curb mounted roof top units shall each be isolated with a continuous roof top isolation assembly consisting of extruded aluminum rails formed to fit curb and equipment with a flexible air and weather seal continuously joining the two rails and incorporating spring isolators sized for 1" static deflection. Flexible weather seals shall be 1/16th inch thick minimum reinforced Neoprene protected from direct sunlight and accidental puncture by an extruded aluminum shield and shall be capable of being replaced completely without disturbing the unit mounting. Springs shall be stable with a KX/KY (horizontal to vertical spring rate) of 1.0 or greater and be properly sized to support the load at 1" static deflection. Isolation assembly shall have Neoprene cushioned wind restraints which are not engaged in normal operation with sufficient capacity to resist wind load in any direction without distortion or damage to the isolated equipment. Entire assemblies shall be shipped in one piece to eliminate field joint and possible leakage. Mason Industries CMAB.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. All isolators shall be installed in strict accordance with the manufacturer's instructions and shall be properly adjusted prior to requesting final inspection or the performance of any vibration testing specified.
- B. Each item of equipment (machinery, piping, etc.) which is provided with vibration isolation equipment shall rest in its intended, proper operating position (i.e. exactly level, etc.) after installation of vibration isolation equipment. Approval of such vibration isolation equipment by Architect/Engineer shall not relieve the Contractor of this responsibility.
- C. Equipment which is specified to rest on concrete housekeeping pads shall have Unit NP pads unless otherwise indicated.

#### **3.2 PIPING IN AIR HANDLING UNIT EQUIPMENT ROOMS**

##### **A. General:**

- 1. Isolators for equipment are described elsewhere in this specification; and it shall be the responsibility of the vibration isolation manufacturer to coordinate the selection of piping supports with equipment supports to provide for a carefully engineered system designed to accommodate expansion and contraction without creating excessive stress at any equipment connections or in any portion of the piping.
- 2. Hangers for horizontal piping shall be installed at regular intervals. Pipe risers shall be supported at the base of the riser. Submit hanger schedule.
- 3. The first three piping supports away from any given piece of vibrating equipment to which piping is connected shall be selected for an operating spring deflection not less than that specified for the equipment isolators. All other vibration isolation supports for horizontal piping shall have a minimum operating deflection of 3/4" with capability of 50% additional travel-to-solid. All supports for pipe risers shall have deflection capability at least four times the expansion or contraction to be accommodated.
- 4. Temporary anchors, where required, shall be installed to permit pre-adjustment of springs in risers. Pre-adjustment procedure, which is intended to control direction of pipe movement and final operating deflection of the springs, shall be detailed in submittal data.
- 5. Permanent limit stops shall be installed to prevent excessive vertical motion of risers in the event water is drained from system. Locations and other details of these limit stops shall be submitted to Architect/Engineer for acceptance.
- 6. Piping connected to vibration isolated equipment shall be installed so that it does not strain or force out of alignment vibration isolators supporting the basic equipment, nor shall pipes restrict such equipment from "floating" freely on its respective vibration isolation system.
- 7. Drain piping connected to vibrating equipment shall not physically contact any building construction or non-isolated systems or components.
- 8. Do not allow the weight of the pipe to be carried by walls through which the pipe passes.

- B. Isolator Locations:
1. Ceiling hung piping to air handling units: Provide neoprene and spring hangers, vertical and angular deflection (Unit NSHVA) at the first three support points of pipe runs connected to the vibrating equipment or at all support points along the first 50 feet of pipe runs connected to the vibrating equipment, whichever length is greater, but not to exceed length of mechanical equipment room.
  2. Floor supported piping to air handling units: Provide resilient support for floor supported piping same locations as specified above for ceiling hung piping. Provide open type unrestrained spring mounts (Unit SMOU) for first three support points; use neoprene-in-shear mounts (Unit NM) thereafter and both with supplemental supports as required by job conditions.
  3. Acoustic Seals: Provide acoustic seals (Unit AS) at all wall, ceiling and floor openings through which pipe runs from equipment rooms into adjoining spaces.

### 3.3 PIPING IN MAIN CENTRAL MECHANICAL EQUIPMENT ROOM

- A. General: The requirements of the paragraph entitled "General", in the above article entitled "Piping in Air Handling Unit Equipment Rooms" shall also apply. Also, the following is applicable:
1. In order to be certain that the piping weight is properly distributed and not distorting the machine flanges, the first four hangers from each machine connection shall be position hangers.
- B. Type and Extent of Piping to Isolated:
1. All piping connected to any kind of pump, pump assembly, chiller, air compressor assembly, air handling unit, or other type of vibrating equipment shall be isolated as follows. This includes (but is not necessarily limited to) piping conveying chilled water, condenser water, condensate, domestic water, fire protection water, make-up water and compressed air.
  2. This spring isolation shall be continuous throughout the piping systems of the main central mechanical equipment room.
- C. Basic Isolator Types:
1. Floor Supported Piping: Unit SMOU, SMOR or SMHU, as applicable.
  2. Piping Suspended from Above: Units NSHVA or NSHVAP, as applicable.
  3. Static Deflection: As recommended by the vibration isolation manufacturer as dependent upon size, length and weight of applicable piping and its conveyed fluid.
  4. Acoustic Seals: Provide acoustic seals (Unit AS) at all wall, ceiling/floor openings through which pipe runs into adjoining spaces.

### 3.4 AIR HANDLING UNITS, FACTORY PACKAGED

- A. Floor Mounted:
1. Spring mounted (Unit SMOU) with 1 inch minimum static deflection when AHU motor is 5 hp. or less; spring mounts with 2 inch minimum static deflection when AHU motor is 7-1/2 hp. or greater. Instead of bolting the units to the spring mounts, provide height saving brackets.
  2. Flexible duct connections as specified in "Duct System Accessories" section.
  3. Flexible pipe connectors (Unit SSB).
  4. Steel equipment frame (Unit SEF) manufacturer's standard unit frame or base is not sufficiently stiff and rigid to permit point vibration isolation.
  5. Mount equipment on reinforced concrete pads as specified in other sections.
- B. Suspended from Building Structure:
1. Spring hangers (Unit NSHV) with 1-inch minimum static deflection when motor is 5-HP or less; spring hangers (Unit NSHV) with 2-inch minimum static deflection when motor is 7-1/2 HP or greater.
  2. Flexible duct connectors as specified in Section entitled "Ductwork".

### 3.5 FAN COIL UNITS AND FANS, IN-LINE CENTRIFUGAL LIGHT DUTY AND HEAVY DUTY

- A. Flexible duct connectors as specified in "Ductwork".
- B. Neoprene-in-shear hangers (Unit NH).
- C. Piping (first 10 feet) with neoprene hangers (Unit NH).

### 3.6 FANS, IN-LINE CENTRIFUGAL HEAVY DUTY

- A. Suspended from Structure:

1. Spring hangers (Unit NSHV) with 1-inch minimum static deflection when motor is 5 HP or less; spring hangers (Unit NSHV) with 2-inch minimum static deflection when motor is 7-1/2 HP or greater.
2. Flexible duct connectors as specified in Section entitled "Ductwork".

3.7 MANUFACTURER'S SUPERVISION

- A. The Contractor shall include in his price the cost of the vibration isolation manufacturer or his qualified representative for providing such supervision as may be necessary to assure correct installation and adjustment of the isolators. Upon completion of the installation and after system is put into operation, the manufacturer or his representative shall make a final inspection and submit his report to the Architect/Engineer in writing certifying the correctness of installation and compliance with approved submittal data.

END OF SECTION

**SECTION 23 05 93**

**PERFORMANCE VERIFICATION, PRELIMINARY**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Put all work in a state of readiness for final performance verification.
- B. Final performance verification shall not begin until the systems are complete and operable in all respects and all related building systems are complete.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.
- B. Refer to the section which describes "Performance Verification, Final".

**PART 2 - PRODUCTS**

This section not applicable.

**PART 3 - EXECUTION**

3.1 AIR SYSTEMS

- A. Prepare the air side for balancing in the following manner:
  - 1. All fans, blowers, and air handling equipment shall be mechanically checked and available to operate under design conditions.
  - 2. All splitters, volume dampers, fire dampers, and vanes shall be in their neutral positions.
  - 3. All grilles, diffusers, and like items, shall be installed with dampers, vanes, and blades in their neutral positions.
  - 4. All controls, whether they are electronic, electric or pneumatic or a combination thereof, shall be mechanically checked and ready to operate under design code in an operable and non-overloading condition.

3.2 ADDITIONAL REQUIREMENTS

- A. Complete Installation: The Contractor shall complete the equipment and system installation to the satisfaction of the Architect/Engineer (who will be the sole judge of its state of readiness) prior to advising, the writing, that final performance verification is ready to begin. The Contractor is hereby advised that the Certificate of Substantial Completion will not be issued prior to the completion of final performance verification work and that he should therefore, schedule all other work accordingly allowing no less than 60 days for completion of final performance verification.
- B. Correction of Defects: The Contractor shall promptly and properly correct all defects in workmanship, material, installation and equipment of which he is aware prior to requesting that final performance verification work begin. Once the final performance verification work has begun, the Contractor shall promptly correct all defects in workmanship, materials, installation, and equipment as they are called to his attention by Architect/Engineer.
- C. Drive Changes: Changes in pulleys or belts required for correct final balance during testing shall be made at no additional cost.
- D. Scheduling and Coordination: The Contractor shall be responsible for proper scheduling and coordination of work involved in preliminary performance verification. This shall include, but is not necessarily limited

to the timely provision of: mechanics, tools, equipment, correction of defects, equipment manufacturer's representatives, test modules, and all other items which may be required.

- E. Report: Submit a written report describing and certifying in detail all preliminary performance verification items and tasks that have been performed. Approval of this report by the Architect/Engineer will precede final performance verification.

END OF SECTION

**SECTION 23 05 94**

**PERFORMANCE VERIFICATION, FINAL**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide the services of an independent test and balance agency to verify the performance of the complete heating, ventilating and air conditioning systems as described by Division 23. Performance verification shall be accomplished by established testing and balancing procedures as described in this section.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

1.4 TEST AND BALANCE AGENCY

- A. All performance verification shall be performed by an independent test and balance agency (herein referred to as the "T & B Agency") which is fully certified by and a current member of the Associated Air Balance Council (AABC).

1.5 CONTRACTUAL RELATIONSHIP

- A. Performance verification shall be performed as a service of the T & B Agency directly to the Contractor with no other subcontractors as part of the agreement.
- B. Performance verification is specified in this Division 23 only because it relates predominantly to Division 23 work. However, the inclusion in this Division 23 of this section covering performance verification shall not preclude the contractual agreement of the T & B Agency from contracting directly to the Contractor with no other subcontractors as part of such agreement.

1.6 AGENCY APPROVAL

- A. Submit the name and qualifications of the proposed T & B Agency to the Architect/Engineer for approval within thirty (30) days of Notice to Proceed.
- B. Include AABC National Project Certification Performance Guaranty.

1.7 WORK INCLUDED

- A. The T & B Agency shall provide all labor, supervision, professional services, tools, test equipment and instruments (except as otherwise specified) to perform the following work and all other work of this section:
  - 1. Review the automatic temperature control and air terminal unit specifications for their respective and combined effects on the testing and balancing procedures for the air and hydronic systems.
  - 2. Where in the opinion of the T & B Agency conditions may exist in the system design or construction that may have the potential of adversely affecting system performance, then the T & B Agency shall identify the condition and submit in writing recommended correctives for consideration by the Architect/Engineer.
  - 3. During construction, review those shop drawings which have relevance to performance verification to confirm that the required piping, ductwork and equipment, and their respective specialties and accessories such as gauges, valves, dampers, access doors, etc., are properly selected, sized and located to permit proper and complete testing and balancing to be accomplished.
  - 4. Perform site inspections to verify compliance with documents, and observe pressure tests on ductwork.

5. Perform a complete air and hydronic test and balance of all heating, ventilating, air conditioning and exhaust air systems and all water and steam systems shown and described on the Construction Documents and as further described herein.
6. Submit Equipment Test and Systems Balance Report.
7. Furnish specifications to Contractor for properly sized fixed sheaves on fan systems after proper RPM has been established.

#### 1.8 EXISTING SYSTEMS

- A. Prior to balancing and testing the new systems, obtain test data on those existing systems which may be affected by the new work. Then, after the new work is provided, rebalance (if and as necessary) those existing systems so that they operate at the same conditions under which they were operating prior to the new work.
- B. The above test data shall be provided as part of the test and balance report. The test data shall include the water and air flow rates and temperatures entering and leaving any equipment items which are part of the existing heating, ventilating and air conditioning system. However, only the fluid affected by the new work need be tested (for example, an air handling unit which is unaffected on its airside but which is affected on its waterside need only have water data obtained). Also, if a piping system branch serves a group of units, then only the flow at the existing branch need be measured and not necessarily the flow at each air handling unit served by the branch (unless measurement at each unit is the only way to obtain the branch total flow).

#### 1.9 GUARANTY

- A. The T & B Agency shall include a warranty period of ninety (90) days after completion and acceptance of test and balance work. During the warranty period, the Architect/Engineer may request a re-check or re-setting of any system component requiring testing and balancing. The T & B Agency shall provide technicians, instruments, and tools to assist the Architect/Engineer in conducting any test that he may require during this time. The foregoing shall be in addition to the A.A.B.C. National Project Certification Performance Guaranty which shall also be provided.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL

- A. The tangible product of this section shall include the reports and documentation necessary to verify the systems' performance.

#### 2.2 REPORT

- A. The T & B Agency shall in the course of his work record the information herein specified. Recorded test data shall be at the final balanced condition for each system. Recorded data shall be arranged by system using the appropriate designation as established on the Construction Documents. Four (4) copies of the final report signed, bound and indexed shall be submitted to the Architect/Engineer for his approval or comments.
- B. Where actual measurements recorded for the final balance show deviations of more than 10% from the design, the T & B Agency shall note same in the report and submit recommendations for corrective action to the Architect/Engineer for his consideration.
- C. In those cases where recorded data can be reasonably interpreted to be inaccurate, inconsistent and/or erroneous, the Architect/Engineer may request additional testing and balancing. The T & B Agency shall at no additional cost perform such retesting and rebalancing as directed by and in the presence of the Architect/Engineer.
- D. Where, in the opinion of the T & B Agency, there is excessive vibration, movement or noise from any piece of equipment, ductwork, pipes, etc., the T & B Agency shall note same in the report and submit recommendations for action to the Architect/Engineer.
- E. The T & B Agency shall verify that each thermostat and the devices it is controlling, such as control valves, motorized dampers, VAV boxes, etc., operate in the exact sequence required.

- F. Test Data: Include the following data in the Systems Test and Balance Report:
1. Motors:
    - Manufacturer
    - Model and serial number
    - Rated amperage and voltage
    - Rated horsepower
    - Rated RPM
    - Corrected full load amperage
    - Measured amperage and voltage
    - Calculated BHP
    - Measured RPM
    - Sheave size, type and manufacturer
  2. Fans:
    - Manufacturer
    - Model or Serial number, BI or Air Foil - number of blades
    - Rated CFM, measured CFM
    - Rated RPM, measured RPM
    - Measured pressures - Inlet and Outlet Static Pressure
    - Pulley size, type and manufacturer
    - Belt size and quantity
    - Rated TSP
    - Operating TSP & operating ESP (at discharge side of Supply Fan or suction side of Exhaust/Return Fan)
  3. Air Systems (including inlets and outlets):
    - Provide single line diagrammatic plan locating each air inlet and outlet and its reference number.
  
    - Grille or diffuser reference number and manufacturer.
    - Grille or diffuser location.
    - Design velocity.
    - Design CFM.
    - Effective area factor and size.
    - Measured velocity.
    - Measured CFM
    - Terminal Unit CFM
- G. Other Report Requirements: Where any systems have equipment or components which are not covered by the above, then the Final Test and Balance Report shall include the following data as applicable to such equipment or systems to confirm actual operation:
1. All inlet and outlet areas.
  2. All applicable duct, pipe and coil sizes.
  3. Outside, inside, mixed and supply air conditions.
  4. All fluid velocities, flow rates, temperatures and pressures at appropriate locations.
  5. All speeds.
  6. All voltage and ampere ranges.
  7. Descriptions of each test method used.

### 2.3 INSTRUMENTATION

- A. All test and balance equipment and instruments to be furnished by the T & B Agency shall have been calibrated within twelve (12) months of use on this work. A list of equipment and instruments to be used shall be submitted to the Architect/Engineer prior to commencing test and balancing operations and shall include equipment and/or instruments, name, manufacturer, serial number and certification of last calibration date. Instruments without calibration adjustment capability shall be accompanied with manufacturer's certification of accuracy. Test and balance equipment and instruments furnished by the Contractor to the T & B Agency shall be accompanied with certification as required above. The T & B Agency shall be responsible for the protection from damage due to accident, abuse or misuse, all equipment and instruments provided by the Contractor, and shall return same in good working condition at the completion of the test and balance work to the Contractor. The T & B Agency shall repair at his expense to original condition and accuracy or replace with like equipment and instruments damaged in the work.



## 2.4 DIAGRAMS

- A. Provide a schematic diagram (i.e., one-line) of duct system(s) tested. Indicate on the diagram the relative location of all air distribution devices, VAV boxes, heating/cooling coils, points of data measurements (i.e., pitot traverse, temperature, static pressure) fans, air handling units, and similar equipment included in the system. Diagram shall identify each component tested. Said identification shall utilize the conventions shown on the drawings (i.e., AHU-1 or SF-6) and correlate with the data sheets provided in the Test and Balance Report.

## 2.5 LOGS AND FORMS

- A. Logs and forms shall clearly indicate following:
  1. All inlet and outlet areas.
  2. All applicable duct, pipe and coil sizes.
  3. Outside, inside, mixed and supply air conditions.
  4. All fluid velocities, flow rates, temperatures and pressures at significant locations (e.g., fluid pressures before and after each pump and fan, temperatures and pressures at supply and return headers and at chiller and boiler inlets and outlets, etc.).
  5. All fan speeds.
  6. All motor ampere ranges.
  7. Descriptions of each test method used.
- B. Associated Air Balance Council log and data forms.

## **PART 3 - EXECUTION**

### 3.1 GENERAL

- A. Sheaves: The Contractor shall provide applicable fans with V-belt drives and fixed pitch sheaves. In order to provide the properly sized fixed pitch sheave, the Contractor shall initially provide fans with V-belt drives, variable pitch sheaves. The Contractor, upon completion of system balancing by the T & B Agency, will replace these adjustable pitch sheaves with fixed sheaves of the size and type specified by the T & B Agency. The Contractor shall tag the adjustable sheaves, transmit same to Owner, and receive written receipt by Owner of acceptance of these sheaves.
- B. Load Conditions: All testing and balancing of systems shall be undertaken with maximum attainable load. Testing and balancing of all air handling systems shall be accomplished with ceiling tile in place and enclosing partitions and doors erected.
- C. Observe all equipment and exposed piping for noise, movement or vibrations under normal operating conditions and report excesses to the Architect and Owner.
- D. Where patented measuring stations are installed, each of these is to be read and recorded. In the hydronic systems, the permanent devices, such as flow tubes with mercury manometers, annular ring systems, venturi tubes with portable meters, etc. must be used for final measurements after they are completed, calibrated and in satisfactory condition.

### 3.2 PERFORMANCE VERIFICATION, PRELIMINARY

- A. The Contractor, prior to commencement of the balancing by the T & B Agency, shall verify in writing:
  1. That strainers have been removed and cleaned.
  2. That all air filters have been installed and are in clean condition.
  3. That expansion tanks have been inspected and that the system is not air bound and is completely filled with water.
  4. That all air vents at coils and high points of the piping systems have been inspected and are installed and operating freely.
  5. That all automatic valves, hand valves, and balancing valves have been left or fixed in the open position for full flow through all devices.
  6. That all linkages between valves or dampers and their actuators are secure.
  7. That all pumps and fans are operating at the specified RPM.
- B. The Contractor shall confirm in writing that the systems as scheduled for balancing, are operational and complete and that all piping and ductwork have been pressure tested and accepted and all affected piping systems have been cleaned, flushed and refilled with prescribed treated water and vented.

3.3 PROTECTION OF WORK

- A. The Contractor shall protect all mechanical devices during the testing and balancing period. The activities of the T & B Agency will include but not be limited to the adjustments of designated balancing devices including; adjustment of balancing dampers, adjustment of inlet vane dampers, adjustment of air extractors, air splitters, or manual dampers, the adjustment of adjustable sheaves for fan speed, the adjustment of balancing valves, or similar devices. The existence of the T & B Agency shall not relieve the Contractor of his responsibility for the complete operation of the mechanical systems in conformance with the contract documents.

3.4 CORRECTION OF WORK

- A. The Contractor shall at no additional cost to the Owner rectify discrepancies between the actual installation and contract documents when in the opinion of the T & B Agency the discrepancy will significantly affect system balance and performance.

3.5 COORDINATION AND ASSISTANCE

- A. The Contractor shall assist the T & B Agency by providing all labor, equipment, tools and material required to operate all of the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic or automated control devices and components. These services shall be available on each working day during the period of final testing and balancing. The Contractor shall assist the T & B Agency by arranging to have all ceilings, partitions, windows, and doors installed prior to the scheduled commencement of balancing within each specified area.
- B. The Contractor shall provide to the approved T & B Agency a complete set of plans and specifications and an approved copy of all heating, ventilating and air conditioning equipment shop drawings. The Contractor shall include the cost of all pulley, belt, and drive changes, as well as balancing dampers required to achieve proper system balance recommended by the T & B Agency.

3.6 AIR SYSTEMS

- A. The testing and balancing shall include, but is not limited to, the following requirements:
1. Adjust fan speeds to deliver the required cfm and static pressure, and record rpm and full load amperes.
  2. Make pitot tube traverse of main supply ducts to verify design cfm. Seal duct access holes with rubber or metal snap-in plugs.
  3. For each supply air system, verify the quantity of outside air and return air when the system is operating in the maximum cooling and full heating modes.
  4. Test and adjust each diffuser, grille and register to within 10% of design requirements, and also adjust so as to minimize drafts in all areas.
  5. Observe all equipment and exposed ductwork for noise, movement or vibration under normal operating conditions and report excesses to the Architect/Engineer.
- B. After all air distribution devices have been balanced to distribute calculated design indicated air quantities and if temperature in any area (where such area does not have the particular zone temperature control thermostat located therein) of any zone is not maintained within 2 degrees plus or minus of the zone areas which does have the zone temperature control thermostat, then notify Architect/Engineer of such conditions and obtain approval to rebalance devices to obtain air quantities other than those indicated so that air temperature in entire zone will be as even as possible regardless of calculated design air quantities. After obtaining approval to rebalance, perform such necessary rebalancing.

END OF SECTION

**SECTION 23 07 00**

**INSULATION, HVAC**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide all work necessary to insulate all equipment, piping, ducts and other items related to the piping and duct systems.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.
- B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:
  - 1. Piping systems.
  - 2. Duct systems.
  - 3. Heat generating equipment.
  - 4. Heat exchange equipment.
  - 5. Cooling equipment.
- C. Vessels, tanks, stacks, and other items which contain or convey fluids which are at such temperatures as to create condensation or surface temperatures which are hazardous or where heat loss or gain prohibits proper system operation.

1.4 SHOP DRAWINGS

- A. General: Refer to the Section entitled "General Mechanical Provisions". Shop drawings shall contain complete descriptive and engineering data, including flame spread and smoke developed ratings (ASTM E84 test method) on all materials and adhesives. Where finishes, covers, or jackets are specified, provide complete data on same. Shop drawings shall contain specified information on: densities, conductivities, conductances, or resistances as required to establish conformance with the specified values or materials.
- B. Industry Standards: Where compliance with an industry, society or association standard is specified or indicated, certification of such compliance shall be submitted with shop drawings.
- C. Commencement of Work: Submit shop drawings before any work is commenced.

1.5 STORAGE OF MATERIALS

- A. Do not store fiberglass insulation within the building until it has been "dried in". If no other dry space is available and this insulation must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.

1.6 COMPLIANCE WITH CODES AND STANDARDS

- A. Applicable Codes: The total insulation system including insulation, sealant, finishes, etc., shall comply with or exceed all code requirements.
- B. NFPA: All materials and adhesives used shall conform to the requirements of NFPA 90A as to flame spread and smoke developed ratings.

## 1.7 DEFINITIONS AND TERMINOLOGY

- A. Terminology: Throughout this section, insulation products may be described as regards the location, surface or other point at which they are to be applied. Except in special cases (where a detailed indication or description will be given), the majority of conditions can be defined in whole or in part by use of (but not necessarily limited to) any or all of the following words:
1. "Internal" or "External".
  2. "Interior" or "Exterior".
  3. "Concealed" or "Exposed".
  4. "Protected" or "Unprotected".
- B. Definitions: Wordage used to describe locations, surfaces or other points or conditions shall be defined as follows as related to this section. Where the ascertainment or determination of locations, surfaces and other conditions is obvious from the intent of use of the item (e.g., roof-mounted ductwork, underground piping, etc.) or from other information, then the following words may not be required. If any ambiguity should occur, provide bid based on the most severe condition; however, obtain clarification from Architect/Engineer prior to installation:
1. "Internal" and "External": Relates to an item or its surface which is to be insulated or uninsulated. Does not relate to the confines of the building, structure or other entity in which the item is located. (Examples: internal/external surfaces of ductwork, pipe, air handling units or other such items.)
  2. "Interior": Relates to the location of an item as to whether the item is within a heated, ventilated, air conditioned or otherwise controlled environment of the building, structure or other entity in which the item is located. "Interior" is always "Protected". (Examples(s): Interior ductwork, interior piping, interior air handling units.)
  3. "Exterior": Relates to the location of an item as to whether the item is outside (i.e., exterior to) a heated, ventilated, air conditioned or otherwise controlled environment of the building, structure, facility or other entity which the item serves or relates. "Exterior" generally means that the item is surrounded by the ambient outside environment. "Exterior" is considered "Unprotected" unless otherwise described. (Examples(s): exterior rooftop air handling units, exterior ductwork, exterior cooling tower.)
  4. "Concealed" and "Exposed": Relates to the visibility of an item. "Concealed" implies out-of-sight from normal view by an occupant, user or employee of the facility when such person is performing their normal function. "Exposed" implies that the item is readily visible by such a person when that person is performing a normal function. (Examples(s): "Concealed interior ductwork" would be out-of-sight in a ceiling plenum, whereas "exposed interior ductwork" would be readily visible in a mechanical equipment room or in a room which intentionally had no ceiling system.)
  5. "Protected" and "Unprotected": Relates to an exterior item which may or may not be sheltered from the outside elements but which exists in contiguous contact with the ambient environment without benefit of any direct heating, ventilating or air conditioning. (Example(s): Piping or ducts located in an open crawl space beneath a building would be "protected/concealed"; in an open parking garage such piping or ducts would be "protected/exposed". Piping or ducts on a rooftop would be "unprotected" and usually "exposed".)

## **PART 2 - PRODUCTS**

### 2.1 GENERAL

- A. Materials: Materials listed are those used as basis of design; equivalent products of acceptable manufacturers will be accepted. Materials must be approved and recommended by the insulation product manufacturer for the particular application(s).
- B. Flame and Smoke Ratings: Application of insulation materials may require, in many cases, that the final insulation system comply with NFPA 90A with regard to maintaining a flame spread rating of 25 or less and a smoke developed/fuel contributed valve of 50 or less. In such cases, verify that the materials comply with the indicated flame spread and smoke developed ratings.
- C. Applicability: Products and manufacturers listed may not all be applicable. Use only those products and manufacturers which are indicated as being applicable to a specific insulation condition.
- D. Acceptable Manufacturers: Manufacturers which are listed are those manufacturers who may make one or more of the insulation products required. Listing of a manufacturer does not necessarily mean the manufacturer is approved for all applicable insulation conditions. Each listed manufacturer must still comply with the specific requirements of each insulation condition to be acceptable for the particular application. Acceptable manufacturers of insulation-related products include (but are not necessarily

limited to) the following: Armstrong; CertainTeed; Childers Products Co.; Knauf; Manville; Owens-Corning; Pittsburg Corning; Rubatex; Upjohn Co.; Duracote Corporation; Ferro Corporation; Dow Corning Corporation; Duro Dyne Corporation; Goodloe E. Moore, Inc.; 3M Co.; United McGill Corporation, Vimasco Corporation; Foster; Gustin-Bacon; Nomaco Inc.; Insulcoustic; Molded Acoustical Products; Lion Nokorode and other manufacturers as may be listed for a specific application.

## 2.2 BASIC MATERIALS

- A. Cellular Glass Insulation: Preformed or block type as indicated or as applicable. Fire, water and vermin retardant; closed cell glass composition; density of 8.5-pcf. Comply with the following: ASTM C 552, "Specification for Cellular Glass Thermal Insulation"; Military Specification MIL-I-24244B. Flame spread rating of "5" and a smoke developed rating of "0" as per ASTM E 84. Recommended temperature applications from -450°F to 1200°F when installed in accord with manufacturer's recommendations. Pittsburg-Corning Foamglas.
- B. Elastomeric Insulation: Preformed (tube), roll or sheet as indicated or as applicable. Nitrile, rubber based, closed cell structure. K factor of 0.28 at 75°F. In tube, roll or sheet form of 3/4-inch thickness or less, ASTM E 84 flame spread rating of "25" or less and smoke developed rating of "50" or less. Recommended temperature applications from -40°F to 220°F when installed in accord with manufacturer's recommendations. Do not install in return air plenums unless flame spread rating and smoke developed rating are within constraints of applicable codes. Manufacturers and/or series: Armstrong "Armaflex"; Manville "Aerotube"; "Rubatex"; Gustin-Bacon "Ultra-Foam".
- C. Fiberglass Insulation: Inorganic fibrous glass. Flame spread of "25" or less and smoke developed rating of "50" or less per ASTM E 84.
  - 1. Board: Rigid or semi-rigid form, faced or unfaced as indicated. Stiffness of 475 EI, 800 EI or 1400 EI as indicated.
  - 2. Blanket: Flexible form; faced, unfaced or coated as indicated.
  - 3. Preformed: Jacketed or unjacketed as indicated.
- D. Calcium Silicate Insulation: Preformed or block type as indicated or as applicable. Asbestos free. Rigid hydrous calcium silicate. K factor of 0.42 at 200°F. Density: 14-pcf. Flame spread rating of "0" and smoke developed rating of "0" as per ASTM E 84. Recommended temperature applications up to 1200 °F. Use where indicated only on equipment and surfaces which generate heat; do not use as a cold-surface insulation.

## 2.3 INSULATION PRODUCTS, BASIC

- A. Type PI-1: Pipe insulation, preformed cellular glass. Pittsburg-Corning "Foamglas" or equivalent.
- B. Type PI-2: Pipe insulation, preformed jacketed fiberglass. Jacketed with factory-applied kraft reinforced foil vapor barrier jacket. Jacket closure system of double pressure-sensitive adhesive on longitudinal joints; self-sealing butt strips at circumferential joints; provide positive vapor barrier seal. Thermal conductivity (K) of 0.24 at 100°F. Owens-Corning Fiberglas ASJ/SSL-II; Manville Micro-Lok with AP-T Plus jacket; CertainTeed 500 Snap-On; or equivalent.
- C. Type PI-3: Pipe insulation, preformed unjacketed fiberglass. Suitable for field-jacketing. Thermal conductivity (K) of 0.23 at 100°F. Owens-Corning Fiberglas No-Wrap, Manville Micro-Lok, or equivalent.
- D. Type PI-4: Pipe insulation, preformed segmental rigid calcium silicate. Thickness as indicated; provide single layer where nominal pipe size allows; provide "factory nested" double layer when nominal pipe size so requires for the thickness indicated. Owens-Corning Kaylo; Manville Thermo-12; or equivalent.
- E. Type PI-5: Pipe insulation, preformed elastomeric. Rubatex, Armaflex II or equivalent.
- F. Type I-1: Cellular glass block insulation. Field formed, fitted and finished as required for the application. Pittsburg-Corning Foamglas or equivalent.
- G. Type I-2: Calcium silicate block insulation. Field formed, fitted and finished as required for the application. Owens-Corning Kaylo; Manville Thermo-12; or equivalent.
- H. Type I-3: Elastomeric insulation. Field formed, fitted and finished as required for the application. Armaflex, Rubatex or equivalent.

- I. Type I-4: Fiberglass flexible blanket insulation. Unfinished, non-combustible, wool-like; composed of long glass fibers bonded with a thermosetting resin. Thermal conductivity (K) of 0.23 at 100°F. Applicable where indicated for boilers, vessels, breaching and stacks operating at up to 1000°F. Finished or held in place by wire ties, metal lath, lagging or as indicated. Owens-Corning Thermal Insulating Wool TIW Type II or equivalent.
- J. Type DI-1: Duct insulation, fiberglass flexible blanket wrap. Composed of flexible blanket of glass fiber factory laminated to a reinforced foil kraft (FRK) vapor barrier with a minimum 2-inch taping and stapling flange on one edge. Suitable for operation at temperatures from 40°F to 250°F. Thermal conductivity of 0.31 at 75°F. Minimum density of three-quarter (3/4) pound per cubic foot. Provide in thickness of (2.2) inches unless otherwise specified as 2-1/2 or 3-inch thickness. Owens-Corning All Service Faced Duct Wrap; Manville R-Series Microlite; CertainTeed Standard Duct Wrap; or equivalent.
- K. Type DI-2: Duct insulation, fiberglass semi-rigid board. Composed of resin bonded glass fibers faced with a foil scrim-kraft (FSK) reinforced laminate of aluminum foil and kraft bonded to provide a metallic surface finish vapor barrier; alternate vapor barrier facing (if specifically indicated) is an all service jacket (ASJ) of high intensity white bleached, chemically treated kraft paper reinforced with fiberglass yarn mesh and laminated to aluminum foil with fire-retardant adhesive to impart a clean, white appearance. Conductivity (K) of not greater than 0.23 at 75°F. Provide in thickness of one (1) inch unless otherwise indicated. Provide with minimum density of 3-pcf unless 6-pcf is specifically indicated. CertainTeed Industrial Insulation Board Type IB-300 (or IB-600); Manville 800 Series Spin-Glas Type 814 (or 817); Owens-Corning 700 Series Industrial Insulation Board Type 703 (or Type 705); or equivalent.

#### 2.4 INSULATION ADHESIVES, MASTICS, SEALANTS

- A. Adhesive (Type A-E1): For joints and seams in elastomeric insulation (Type I-3) not requiring weather protection. Rubatex R-373 Insulation Adhesive; Armstrong 520 Adhesive or equivalent.
- B. Joint Sealant (Type JS-CG1): Non-hardening vapor barrier sealant specifically designed for use with cellular glass insulation (Types PI-1, I-1): Foster's 35-40 Foamseal Sealant, Pittsburg-Corning Pittseal 111 Sealant or equivalent.
- C. Adhesive (Type A-F1): For adhering fiberglass blanket and board insulations (Types DI-1, DI-2) to metal substrate such as ductwork. Insulcoustic I-C 201, Foster 85-20 or equivalent.
- D. Mastic, General Purpose (Type M-GP1): Non hardening vapor barrier general purpose mastic. For use where indicated or otherwise applicable. Foster GPM 35-00 or equivalent.

#### 2.5 INSULATION FINISHES, JACKETS AND COVERS

- A. Finishing Coating (Type FC-E1): For weather protection of elastomeric insulations (Types I-3, PI-5). Rubatex 374 coating; Armstrong Armaflex Finish or equivalent.
- B. Finish Mastic (Type FM-CG1): For cellular glass insulations (Types PI-1, I-1). Waterproof, weather, acid and alkali resistant asphalt mastic coating for use in the range of -40°F to 200°F (installation must be done when in the 50°F to 120°F range). Pittsburg-Corning Pittcote 300 Vapor and Weather Barrier Finish or equivalent.
- C. Finish Fabric (Type FF-CG1): For cellular glass insulations (Types PI-1, I-1). 6 x 6 meshes per inch polyester fabric for reinforcing the finish mastic. Pittsburg-Corning PC Fabric 79 or equivalent.
- D. Finish Fabric, General Purpose (Type FF-GP1): Nylon membrane. For use generally with fiberglass duct insulations (Types DI-1, DI-2) at joints or seams or as may be indicated. Apply using Foster GPM 35-00 or equivalent.
- E. Jacket, Underground Pipe (Type JP-CG-1): For cellular glass pipe insulations (Type PI-1, I-1) where indicated. Prefabricated laminate containing a 20 x 10 mesh asphalt impregnated glass fabric and a 1-mil thick aluminum foil sandwiched between three layers of a bituminous mastic. External jacket surface coated with a protective plastic film and internal surface with a special release paper. Apply around cellular glass pipe insulation in a cigarette type wrap with the overlap heat sealed. Seal butt joints in the same manner using a 4-inch wide seal strip of the jacketing. Irregular surfaces of the pipe system shall have the jacket's plastic film burned away prior to application of a 20 x 10 asphalt impregnated mesh which shall be sandwiched between two glove coats of finish mastic (Type FM-CG1).

- F. Jacket, Pipe, PVC (Type JP-PVC): All purpose, UL-rated, white vinyl jacket, with or without self-sealing feature. Pittsburg-Corning "UNI-JAC" or equivalent.
- G. Jacket, Pipe, Aluminum (Type JP-A1): Aluminum jacketing, 0.016 inches thick, type 3003 alloy, H-14 temper, circumferentially corrugated, with a continuously laminated moisture barrier of one mil polyethylene film and a protective layer of 40 lb. virgin kraft paper. Childers Products Co. "Corolon"; General Aluminum Supply Co. (Gasco); Insulcoustic "Alcorjac" or equivalent.
- H. Pipe Fitting Covers, PVC (Type PFC-PVC): Insulated polyvinyl-chloride fitting covers in shapes as required; with fiberglass insulation insert. Suitable for temperature range of 0°F to 450°F. Flame spread rating of 25 or less and smoke developed rating of 50 or less when kept below 150°F. Acid, alkali and chemical resistant. Suitable for painting if required. Manville Zeston 25/50 PVC Insulated Fitting Covers or equivalent.
- I. Pipe Fitting Covers, Aluminum (Type PFC-A1): Aluminum fitting covers, 0.020 inches minimum thickness, type 3003 alloy, H-14 temper prefabricated fitting covers with baked epoxy moisture barrier for pipe sizes through 24". Field fabricate fitting covers for pipe sizes larger than 24" using 0.020 inches thick aluminum roll jacketing with laminated polyethylene/kraft moisture barrier. Childers Products "Ell-Jacs", "Gore Ell-Jacs", "Tee-Jack", "End-Caps", and "Flange Jacs" or equivalent.

## 2.6 RELATED PRODUCTS

- A. Wire (Type W-1): Dead soft, 16-gauge, stainless steel.
- B. Straps (Type ST-1): Stainless steel T-304 (18-8) soft annealed with deburred edge with stainless steel wing seals. Childers Products "Febstraps" or equivalent.
- C. Tape (Type T-1): High tensile strength rope stock flat back paper pressure sensitive tape. Pittsburg-Corning "PC Tape No. 25" or equivalent.
- D. Screws (Type S-1): Aluminum pan head type "A" slotted #8 by 1/2-inch.

## **PART 3 - EXECUTION**

### 3.1 GENERAL

- A. Field Forming, Fitting and Finishing: Where preformed insulation products are indicated as being acceptable for a particular application, provide field formed, fitted and finished insulation systems if such application is more practical (such as due to size, configuration or dimensions which may be outside of the availability ranges for size, dimension and/or thickness of preformed products).
- B. Pre-installation:
  - 1. Do not apply insulation adhesives, materials or finishes until the item to be insulated has been completely installed and tested and proved tight and suitable for insulation.
  - 2. Prepare surfaces to be clean and dry before attempting to apply insulation.
- C. Insulation Shields: Provide hanger or pipe support shields of 16 gage (minimum) galvanized steel over or embedded in the insulation. Shield shall extend halfway up the pipe insulation cover and at least 6" on each side of the hanger. Securely fasten shield with pipe straps at each end.
- D. Valves, Cocks and Specialties: Insulate as for the related piping system in which they are located unless otherwise indicated.
- E. Factory Pre-insulated Components: Where equipment and other system components are specified in other sections to have factory installed insulation, then no additional insulation is required as work of this section unless additional non-factory-installed insulation is specifically described. Examples of such equipment and components which may not require additional insulation include, but are not necessarily limited to, boiler vessels, chiller evaporators, air handling units, airside terminal units, and similar items.
- F. Minimum Thicknesses: Insulation thicknesses which are indicated are minimum thicknesses. Contractor may provide the same insulation material in greater thickness as an aid to installation and handling procedures or due to material availability and procurement considerations.

- G. Branch Runouts: Branch runouts are considered to be individual supply/return pipes to individual terminal heating or cooling units (duct mounted coils, airside terminal units with heating coils, fan coil units, humidifiers, and similar small equipment). The supply/return pipe to such units is not considered to be a branch runout if the length of the supply or return pipe exceeds 12'-0" in length to the coil/unit connection.
- H. Steam Supply Piping Systems and Steam Condensate Return Piping Systems:
  - 1. Supply Piping System: Shall be considered as the portion of the steam piping systems which conveys steam to a point of direct use at an equipment item which utilizes the steam for humidification or other useful purpose. Such piping conveys steam in or at its vapor phase condition.
  - 2. Condensate Return Piping System: Shall be considered as all portions of the steam piping system which are not part of the steam supply pipe system. Such piping generally conveys steam condensate, exhaust or vented steam, feedwater, blowdown and similar forms of piping on the low pressure (downstream) side of steam traps and relief valves.
- I. Steam System Classifications: Steam systems of the following classifications shall be considered to operate within the following temperature and pressure ranges. See performance data scheduled, specified or shown for applicable operating conditions.
  - 1. Low pressure: 0 to 15-psig; up to 250°F.
  - 2. Medium pressure: Between 15-psig and 60-psig; between 251°F and 305°F.
  - 3. High pressure: Over 60-psig; between 306°F and 450°F.
- J. Insulation for Plumbing Systems: See other sections describing insulation for plumbing systems.

### 3.2 DUCT SYSTEMS

- A. General:
  - 1. Locations and extent of both internal and external insulation for duct systems are described in section entitled "Ductwork" and/or by the "Duct Type and Location Schedule" on the Drawings.
  - 2. Internal Insulation: Ductwork which is required to be insulated internally (acoustically/thermally lined) shall be insulated as work of the section entitled "Ductwork".
  - 3. External Insulation: Ductwork which is required to be insulated externally shall be insulated as work of this section.
  - 4. Factory Insulation: Ductwork which is factory manufactured with internal or external insulation is not to be additionally insulated as work of this section unless specifically stated. Such factory insulated ductwork generally consists of flexible externally insulated ductwork and double walled acoustically thermally lined ductwork.
- B. Interior, Concealed (e.g., ceiling plenums): Where external insulation is required, insulate externally with 2.2 inch thick fiberglass blanket wrap (Type DI-1). Adhere duct insulation using adhesive (Type A-F1) applied in accordance with the manufacturer's recommendations. Where duct width exceeds twenty-four inches (24"), the insulation shall be additionally secured to the bottom of the duct using mechanical fasteners spaced one foot (1') on center. Insulation shall be applied with edges tightly butted, and all joints and breaks in the vapor barrier sealed using glass fabric and mastic applied in conformance with manufacturer's recommendations.
- C. Interior, Exposed, (e.g., air handling unit rooms): Where external insulation is required, insulate with 1-inch thick semi-rigid fiberglass board (Type DI-2). Adhere to ductwork with adhesive (Type A-F1). Finish joints and seams with finish fabric (Type FF-GP1).

### 3.3 DUCT SYSTEMS EQUIPMENT

- A. General: Insulate as follows unless detailed to a greater extent on the Drawings.
- B. Fire damper and Fire/Smoke Damper External Surfaces:
  - 1. Externally Insulated Duct Locations: Extend duct insulation up face of fire damper to damper sleeve. Seal insulation edges with 4-inch minimum width duct tape.
  - 2. Internally Insulated Duct Locations: Provide additional external insulation from a point on the duct 12 inches from the fire damper to the fire damper and on the face of the fire damper to the fire damper sleeve. Seal insulation edges with 4-inch minimum width duct tape.
- C. Air Distribution Devices: Insulate the backs of all ceiling diffusers and other air outlet devices installed in other than return air plenums as specified for interior concealed ducts.



3.4 COLD EQUIPMENT AND RELATED COMPONENTS

A. Condensate Drain Piping From Cooling Equipment:

1. Interior, and Exterior, Protected: Insulate with preformed elastomeric pipe insulation (Type PI-5) secured with adhesive (Type A-E1) and finished with white finish coating (FCC-E1). Thickness 3/4-inch. Provide 25/50 flame/smoke rating.
2. Exterior, Unprotected: None applicable.

END OF SECTION

**SECTION 23 23 13**

**REFRIGERANT PIPE, VALVES AND SPECIALTIES**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide refrigerant piping systems, complete in all respects, between the system components and connected equipment.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division-23 and to all other applicable portions of the Drawings and Specifications.

1.4 SHOP DRAWINGS

- A. Refer to the Section entitled "General Mechanical Provisions".

**PART 2 - PRODUCTS**

2.1 COPPER PIPE

- A. Refrigerant system piping shall be refrigerant grade, dehydrated and sealed, seamless, uniformly dead soft temper.

2.2 FITTINGS

- A. Refrigerant grade, wrought copper, long radius, solder joint type.

2.3 SOLDER

- A. Silver brazing alloy (Sil Fos) Fed. Spec. AA-S-56ld.

2.4 FLUX

- A. Non-corrosive, specifically designed for silver brazing.

2.5 ACCESS VALVES

- A. Schrader type designed for use with quick coupler hose fittings and provided with individual cap.

**PART 3 - EXECUTION**

3.1 PIPE SIZES

- A. Refrigerant pipe sizes which may be shown on drawings are nominal. Provide sizes not less than sizes indicated and in compliance with size recommended by the manufacturer(s) at the connected equipment. Provide change in sizes if such change is in accord with manufacturer's recommendation and with Architect/Engineer's approval. Size piping to maintain minimum velocity of 500-fpm in horizontal lines and 1000 fpm in vertical risers for proper oil return; provide double suction risers and hot gas risers as may be necessary to accomplish this.

### 3.2 REFRIGERANT SPECIALTIES

- A. Refrigerant valves, driers, expansion valves, and similar items shall be provided with each system. Where refrigerant access valves are not furnished by the manufacturer, they shall be field installed to enable charging and checking the system.

### 3.3 JOINTS AND CONNECTIONS

- A. General: All joints and connections shall be made permanently refrigerant tight.
- B. Solder Joints: Cut tubing square using tubing cutters, with sharp cutting wheels, so as not to crimp the tubing ends. Remove all burrs using a pipe reamer and taking care not to flare the ends of the tube. Thoroughly clean the outside of the pipe and the inside of the fitting using a fine sand cloth. Apply non-corrosive paste flux to the cleaned surfaces immediately and apply silver solder and heat in accordance with manufacturer's instructions. Use care not to damage equipment or refrigerant specialty items when making up joints (protect from excessive heat).
- C. Scale Prevention: During brazing, keep pipe system full of inert gas to prevent scale formation.
- D. Mechanical Joints: Where the Contractor uses refrigerant tubing sets, follow the manufacturer's installation instructions explicitly, including the use of special tools, when making up the joints. Where precharged tubing and equipment is provided, do not cut into the system to install access valves.

### 3.4 HANGERS AND SUPPORTS

- A. Refer to other sections describing hangers and supports. Isolate copper tubing from contact with any dissimilar metals.

### 3.5 EVACUATION AND CHARGING

- A. When other than completely factory charged equipment and piping systems are used, they shall be evacuated and charged as follows: Charge the system with dry nitrogen and refrigerant and leak test all joints including factory piping within the units. Repair all leaks by disassembling and remaking the joint. After all leaks are corrected, evacuate the system to an absolute pressure of 0.2" mercury. System shall hold this vacuum for two hours with no noticeable rise in pressure. After passing vacuum test, break vacuum twice using refrigerant and re-evacuate for a minimum of two hours each time. Charge the system in the manner and with the type and amount of refrigerant recommended by the manufacturer and in accordance with accepted refrigeration practice.

### 3.6 REFRIGERANT PIPING CONDUIT

- A. Install any refrigerant piping which is below slab or grade in Schedule 40 PVC piping. Size conduit as necessary to properly install piping. Provide long bend sweeps. Install so that conduit will drain and not trap water. Protect ends of conduit from entry by vermin, insects and water.

### 3.7 OTHER REQUIREMENTS

- A. Arrange piping generally as shown and such that service access is facilitated. Keep refrigerant lines as short and direct as possible with a minimum number of joints. Provide sleeves through floors, walls or ceilings, sized to permit installation of full-thickness insulation; seal air tight after installation of piping and insulation.
- B. Provide flexible piping arrangement in hot gas discharge line of compressor. Such arrangement shall consist of a piping loop or similar measure to prevent transmission of objectional vibration.
- C. Provide a removable core filter-drier in liquid line. In-line filter-driers are acceptable in individual circuits of less than 10-ton nominal capacity. Provide a full size valved bypass around this filter-drier. Provide shut-off valves to isolate the filter drier while flow is through the bypass and also a shutoff valve in the bypass so that filter-drier can be put into use.
- D. Provide a refrigerant charging connection in the liquid line upstream from the filter-drier.

- E. Provide a moisture indicating sight glass in the liquid line downstream from the filter-drier. Install in vertical line if possible and a sufficient distance downstream from any valve such that the resulting disturbance does not appear in the glass.
- F. Provide a filter-drier with isolating shut-off valves and with valved bypass only if compressor is not equipped with a suction line filter or screen.
- G. Keep piping free from traps unless otherwise indicated. Install vertical pipe plumb. Pitch horizontal piping only where slope is desirable.
- H. Provide shut-off valves at inlet and outlet to all condensers, receivers and evaporators to permit isolation for service. If possible, use angle valves to minimize pressure drop. Use angle valves in all cases at receivers. Use globe valves only when angle valves are impractical.
- I. Provide solenoid valves upright in horizontal lines only, unless their design allows installation in vertical pipe.
- J. Where compressor(s) do not have pump down control and the compressor(s) associated evaporator coil(s) do not have bottom suction header connections and the evaporator coil(s) are located above the compressor(s), then loop suction lines(s) to top level of coil to prevent liquid slugging.
- K. To prevent erratic operation of thermal expansion valve, provide a suction line trap next to evaporator coil suction outlet with expansion valve bulb located between coil and trap. Provide only in suction lines which are level leaving coil outlet or which rise on leaving coil outlet. Trap not required when evaporator coil outlet suction line drops to compressor or suction header immediately after expansion valve bulb.

END OF SECTION

**SECTION 23 31 00**

**DUCTWORK**

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

**1.2 SCOPE**

- A. Provide complete duct systems as indicated. Systems shall include, but not be limited to, the following: outside air, exhaust air, and air conditioning supply and return air duct systems as shown on drawings. Drawing scales prohibit the indication of all offsets, fittings, and like items; however, these items shall be installed as required for the actual project conditions at no change in contract price.
- B. Items Included: This section generally includes, but is not limited to, the following major items:
  - 1. Low pressure sheet metal ductwork.
  - 2. Acoustical thermal duct liner.
  - 3. Low pressure flexible ducts.

**1.3 RELATION TO OTHER WORK**

- A. Refer to the section, "General Mechanical Provisions" for related requirements. Refer to other sections of Division 23 and to other applicable portions of the Drawings and Specifications.
- B. This section is directly related in particular to sections (which may or may not be included in this division) which describe the following:
  - 1. Sections describing air handling equipment and fans.
  - 2. Air distribution devices.
  - 3. Terminal units.
  - 4. Duct system accessories.
  - 5. Insulation.
- C. Coordinate shop drawings, ordering, delivery, and placement of all items affecting the duct systems including, but not limited to, the following items: air handling units, exhaust fans, supply fans, sound attenuators, duct mounted coils, access panels, air distribution devices, fire dampers, outside air louvers, hoods, filters, roof curbs, structural framing, roof construction, roofing, and the work of all trades to insure an orderly and timely progression of the work. Refer to the requirements of Section entitled "General Mechanical Provisions".
- D. Refer to other sections which may describe additional sound attenuation measures which may relate to this section.

**1.4 SHOP DRAWINGS**

- A. Refer to Section entitled "General Mechanical Provisions". Include complete data as applicable to this project on: all prefabricated duct and fittings; duct liner including mechanical fasteners and adhesives; duct sealing materials; duct joining and seaming methods; and all other items. If required by Architect, prepare and submit for approval completely detailed shop drawings of supply and return ductwork from any or each air handling unit through its transitions, bends and elbows until such ducts are extended beyond the air handling unit equipment area and/or congested areas; these shop drawings will not be required unless specifically called for elsewhere or unless significant deviation from the Drawings is necessitated by the equipment provided.

**1.5 OTHER REQUIREMENTS**

- A. Provide all ductwork and components thereof in accord with manufacturer's recommendations. All ductwork dimensions indicated are nominal free clearance internal dimensions which do not include insulation thickness.

1.6 DEFINITIONS

- A. "SMACNA" means "Sheet Metal and Air Conditioning Contractors National Association, Inc."
- B. Low Pressure Ductwork: Any and all ductwork conveying air or other gases at velocities less than 2500 fpm and static pressure less than 2.0 inches wg. This ductwork may also be referred to in these specifications as "Low Velocity Ductwork". SMACNA "HVAC Duct Construction Standards, Metal and Flexible", Second Edition, 1995, shall govern construction of this ductwork unless otherwise specified.
  - 1. Where and if fiberglass ductwork is specified, it shall be considered only for low pressure classification use and shall be constructed in accord with SMACNA "Fibrous Glass Duct Construction Standards", Fifth Edition, 1977.

1.7 PRESSURE/VELOCITY CLASSIFICATIONS

- A. Pressure and velocity classifications (hereinafter called "P/VC") for ducts are defined as follows:

<u>P/VC Desig.</u>	<u>SMACNA Pressure Class</u>	<u>Static Pressure Rating</u>	<u>Positive or Negative Pressure</u>	<u>SMACNA Seal Class</u>	<u>Maximum Velocity (fpm)</u>
10	High	10"	+	A	2000 up
6	Medium	6"	+	A	2000 up
4	Medium	4"	+	A	4000 dn
3	Medium	3"	+ or -	B	4000 dn
2	Low	2"	+ or -	C	2500 dn
1	Low	1"	+ or -	C	2500 dn
½	Low	1/2"	+ or -	C	2000 dn

- B. See Part 3, EXECUTION, of this section for duct sealing requirements.

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. Materials shall comply with current SMACNA standards.
- B. ASTM: Unless otherwise specified, ASTM material specifications applicable are:

<u>Material</u>	<u>Type</u>	<u>ASTM Number</u>
Galvanized steel	G90	A525
Stainless steel	304,316	A240
Cold rolled steel	20-28 ga.	A366
Cold rolled steel	18 ga.	A619
Aluminum	3003 H-14	B609

- C. Special Materials, Gauges and Construction:
  - 1. Special Materials: Where special duct material other than galvanized steel is required, such duct material (e.g., fiberglass, stainless steel, plastic such as polyvinylchloride, etc.) shall be specifically indicated.
  - 2. Gauges: Gauges indicated in this section are for galvanized steel. Where greater or lesser gauges are specifically indicated for a sheet metal material other than galvanized steel, provide the indicated gauge. Comply with the SMACNA construction standard covering the required material if no gauge is given.
  - 3. Construction: Comply with indicated special requirements (i.e., such as welding, soldering, etc.) where application requires.

2.2 LOW PRESSURE SHEET METAL DUCTWORK

- A. Material: Prime quality forty-eight inch wide resquare tight coat galvanized steel conforming to the requirements of ASTM A-525 and/or A-527 as applicable to the intended use.
- B. Construction:
  - 1. Construct to comply with the pressure/velocity classification(s) indicated.

2. Use rectangular or round as indicated on drawings.
3. Reinforcing, Cross Breaking, Seams, Joints: Be in accord with latest SMACNA construction standard for low pressure sheet metal duct.
4. Gauge: As required by SMACNA for the dimensions and pressure/velocity classification involved.

C. Insulation:

1. Rectangular rigid sheet metal ductwork: shall be internally lined with acoustical thermal duct liner if so designated.
2. Round rigid sheet metal ductwork: Where low pressure round ductwork is designated to have internal acoustical/thermal liner, provide factory fabricated double wall ductwork as specified for high pressure round acoustically lined sound attenuating duct (i.e., factory fabricated double wall duct with perforated inner wall).

2.3 ACOUSTICAL THERMAL DUCT LINER

- A. Line ductwork where indicated. Dimensions indicated are net inside dimensions. Liner shall be one inch thick, three pound density fiberglass duct liner with the surface in contact with moving air stream stabilized with black pigmented neoprene. Duct liner shall comply with requirements of NFPA 90A as to flame spread and smoke developed ratings. Duct liner shall be factory treated with antimicrobial/antibacterial treatment to prevent formation & growth of bacteria.
- B. Acceptable Manufacturers: Johns-Manville, Microtex; PPG Industries, Testrafine; or Certain-Teed/Saint Gobain, Coated Ultralite.
- C. Attachment: Attach to the interior of sheet metal ducts using a full coverage coat of Foster's 85-20 adhesive and mechanical fasteners applied as follows:
  1. Horizontal Ducts: Install mechanical fasteners on underside of the tops of ducts over twelve inches in width and on the insides of ducts over sixteen inches in height.
  2. Vertical Ducts: Install mechanical fasteners on all duct surfaces exceeding twelve inches.
  3. Fastener Spacing: Install fasteners within two inches of the leading edge of each duct section and within three inches of the leading edge of cross joints in insulation within any given duct section. Pins shall thereafter be spaced at not more than fifteen inches on centers. Pins shall be installed in strict accordance with manufacturer's instructions.
- D. Edge Stabilization: All exposed edges and the leading edge of all cross joints of liner shall be coated with Foster's 30-36.

2.4 LOW PRESSURE FLEXIBLE DUCTS

- A. General:
  1. The inclusion of flexible ducts in this specification shall not be construed as approval of use on the project unless specifically shown on the Drawings.
  2. Where used, provide in factory finished lengths not in excess of lengths required to make kink-free connections with minimum air pressure drop.
- B. Insulated flexible ducts: Flexible duct shall be factory-fabricated preinsulated type with seamless vapor barrier. Duct shall bear UL 181 Class 1 Air Duct label and shall comply with NFPA 90A and 90B. Fiberglass insulation nominal 1" thickness with thermal conductance of 0.23 BTU/hr-ft<sup>2</sup>-°F maximum at 75°F mean temperature. Flexible duct shall have an operating range of minus 0.5" w.g. to plus 2" w.g. Core shall be continuous and consist of aluminized mylar laminated to corrosion resistant steel wire helix. Vapor barrier perm rating shall be 0.17 maximum per ASTM E96-A. Maximum working velocity shall be 4000 FPM. Flexible duct shall be Genflex SLR-25, Clevaflex Type KQ, Wire Mold type WG, Flexmaster Type 5B, or approved equal.
- C. Un-insulated flexible ducts, steel: Flexible ductwork shall be constructed of all metal one ply hot-dipped galvanized steel, closely corrugated for strength and flexibility, with seams interlocked, folded flat, and knurled to insure tightness. Duct shall be listed as #UL181 "Flexible Air Duct", Class 1, and NFPA 90A. Products shall be Flexmaster Type NI-TL, Clevaform Type GS or approved equal.
- D. Round branch take-off fittings for flexible duct:
  1. Round duct branch take-off fitting shall be made of galvanized sheet metal designed for twist-in installation and to assure minimum air loss at the take-off. The fittings shall be of the conical converging type to reduce the pressure drop through the fittings. Provide a raised bead on the throat

of the fitting to assure a tight positive connection. Products shall be Flexmaster Model CB-DE-BO3 or approved equal.

2. Provide each fitting with the following:
  - a. Lockable quadrant damper.
  - b. 45-degree extractor scoop.
  - c. Insulation guard where used with internally lined ductwork.
3. Provide these "spin-in" type fittings at all connections between rigid sheet metal duct and flexible duct at the upstream end of the flexible duct.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. All duct systems shall be free of noise, chatter, vibration and pulsation under all conditions of operation. Remove, replace or reinforce as directed by the Architect/Engineer if necessary to correct such conditions.
- B. If field conditions are determined to exist which would limit the guarantee of air delivery or system performance, due notice in writing shall be submitted to the Architect/Engineer of such conditions prior to starting fabrication.
- C. Properly support and align ductwork. Ducts to be free of sag and bulge. Hang ductwork below concrete floors or roof deck with hangers set prior to pouring concrete, or from self drilling screw anchors. GUN POWDER SET ANCHORS ARE NOT PERMITTED.
- D. Where it is necessary that ducts be divided due to pipes or other obstructions which must pass through these ducts, the Contractor shall, at locations as noted or directed, provide air-stream deflectors in the duct and the duct shall be increased in size to maintain equivalent area around deflectors. Such changes shall be in accord with standard SMACNA details and shall be shown on Contractor's As-Built Drawings.
- E. Interior of ductwork visible through registers, grilles, or diffusers shall be painted flat black.
- F. Do not route ductwork through transformer vaults and electrical equipment spaces and enclosures.
- G. Construct all ductwork and accessories in accord with the latest indicated editions of applicable SMACNA construction standards. Sheet Metal and Air Conditioning Contractors' National Association.
- H. Streamline all ductwork to the full extent practical and equip with proper and adequate devices to assure proper balance and quiet draftless distribution of indicated air quantities.
- I. Protect all ductwork and system accessories from damage during construction until Architect/Engineer's final acceptance of project.
- J. Prior to ductwork fabrication, verify if all ductwork as dimensioned and generally shown will satisfactorily fit allocated spaces. Take precautions to avoid space interferences with beams, columns, joists, pipes, lights, conduit, other ducts, equipment, etc. Notify Architect/Engineer if any spatial conflicts exist, and then obtain Architect/Engineer's approval of necessary routing. Make any such necessary revisions which are minor at no additional cost.
- K. Carefully correlate all duct connections to air handling units and fans to provide proper connections, elbows and bends which minimize noise and pressure drop.
- L. Provide all curved elbows with radius ratios of not less than 1.5 unless otherwise shown or approved by Architect/Engineer. Provide all mitered elbows with turning vanes.
- M. Properly suspend all ductwork so that no objectionable conditions result (such as vibration, sagging, etc.).
- N. Coordinate any and all dimensions at interfaces of dissimilar type of ductwork and at interfaces of ductwork with equipment so that proper overlaps, interfaces, etc., of insulation and continuity of vapor barriers are maintained.
- O. If necessary where ducts interface and have different types of insulation, provide transitions so that internal free-clear dimensions of duct remain unchanged.



- P. Install horizontal low pressure ductwork at a level which maximizes length of any vertical, rectangular or round rigid duct connections to rectangular diffuser necks; however, such vertical duct connections are not required to be over 24 inches in length.
- Q. Make connections from any low pressure ductwork to terminal units (fan terminal units, variable volume boxes, etc.) with appropriate lengths of flexible duct unless other type of connection is indicated.
- R. Install all flexible round duct without kinks or similar obstructions so that pressure drop is minimized. Cut and remove excess lengths as necessary.
- S. Install horizontal rigid ductwork as high as practical above suspended ceilings so that movable light fixtures may be relocated without interference to meet any future partition relocation requirements.
- T. Insulated Duct: Where ducts will be insulated, make provision for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. A metal collar equivalent in depth to insulation thickness and of suitable size to which insulation may be finished shall be mounted on duct.

### 3.2 LOW PRESSURE SHEET METAL DUCTS

- A. If width or height of rectangular duct exceeds 12 inches, cross break or roll a cross bead in panels to increase stiffness; otherwise, use two gages heavier steel.
- B. Provide corner closures. Longitudinal seams and transverse joints shall be flat and smooth inside. Make slip joints in direction of air flow. See governing SMACNA manual for transition requirements.
- C. Fabricate offsets, turns and elbows with centerline radius equal to 1-1/2 times diameter when possible. No mitered offsets will be allowed. Provide double thickness turning vanes to assist in smooth flow of air in square elbows or elbows with centerline radius less than duct width or diameter.

### 3.3 LOW PRESSURE FLEXIBLE DUCTS

- A. Flexible ducts shall not be used unless specifically indicated on drawings.
- B. If flexible duct is indicated for use on this project, it must comply with the following requirements.
  - 1. The extent of the use of flexible ductwork shall be limited to that shown on the drawings.
  - 2. Flexible duct installation shall be per SMACNA Flexible Duct Installation Standards, and manufacturers latest printed instructions, whichever is stricter. In addition the following shall apply:
    - a. Flexible duct between rigid duct and diffusers shall be a MAXIMUM of 8 feet in length and shall be fully extended with a maximum equivalent of (2) 90 degree bends (no bend shall be made with centerline radius of less than one duct diameter). No additional flexible duct shall be provided for future terminal device relocation unless otherwise specified.
    - b. Flexible duct shall be supported at ends and at each 90 degree bend. Maximum permissible sag is 1/2 inch per foot of spacing between supports.
    - c. Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1 inch wide. Narrower hanger material may be used in conjunction with a sheet metal saddle which meets the foregoing specifications. This saddle must be formed to cover one-half the circumference of the outside diameter of the flexible duct and must be rolled to fit neatly around the lower half of the duct's outer circumference.
    - d. Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when manufacturers recommended procedures are followed.
    - e. Hangers shall be adequately attached to the building structure (not pipe, conduit, etc.).
    - f. To prevent tearing of vapor barrier, do not support entire weight of flexible duct on any one hanger during installation. Avoid contact of flexible duct with sharp edges of hanger material. Damage to vapor barrier may be repaired with approved tape. If internal core is penetrated, replace flexible duct or treat as a connection.
  - 3. Terminal devices connected by flexible duct shall be supported independently of the flexible duct.

3.4 MISCELLANEOUS DUCT SYSTEM COMPONENTS

- A. Spin-In Take-Off Fittings: Install around duct branch takeoff fittings according to manufacturer's installation instruction. Additionally seal fitting to rectangular duct with a thin bead of mastic sealant.

3.5 HANGERS AND SUPPORTS

- A. General: Comply with latest applicable SMACNA construction standard. Where sprayed fireproofing occurs, install hangers before application of such treatment and withhold installation of ducts until after application.
- B. Supports: Vertical risers and other duct runs where the method of support specified above is not applicable shall be supported by substantial angle brackets designed to meet field conditions and installed to allow for duct expansion.
- C. Fasteners: Secure hangers to steel beams or metal deck with beam clamps or drop through connections from the metal or concrete deck.

3.6 CHANGES IN SHAPE OR DIMENSION

- A. Where duct size or shape is changed to effect a change in area, the following shall apply:
  - 1. Where the area at the end of the transformation results in an increase in area over that at the beginning, the slope of the transformation shall not exceed one inch in seven inches.
  - 2. Where the area at the end of the transformation results in a decrease in area from that at the beginning, the slope of the transformation may be one inch in four inches, but one inch in seven inches is preferable, space permitting.
  - 3. The angle of transformation at connections to heating coils or other equipment shall not exceed thirty degrees from a line parallel to the air flow on the entering side of the equipment, nor fifteen degrees on the leaving side. The angle of approach may be increased to suit limited space conditions when the transformation is provided with vanes approved by the Architect/Engineer.

3.7 CHANGES IN DIRECTION

- A. Changes in direction shall be basically as indicated on the drawings and the following shall apply:
  - 1. Supply duct turns of ninety degrees in low pressure duct shall be made with mitered elbows fitted with closely spaced turning vanes designed for maintaining a constant velocity through the elbow.
  - 2. Return and exhaust duct turns of ninety degrees in low pressure duct shall be made with mitered elbows, as specified hereinbefore for supply ducts, unless radius elbows are indicated in which case they shall be constructed with a turning radius one and one-half (1-1/2) times the width (with width considered as the dimension in the plane of the turn) as measured to the duct centerline.
  - 3. Tees in low pressure duct shall conform to the design requirements specified hereinbefore for elbows.
  - 4. Branch take-offs in low pressure supply duct shall be made with extractors or splitter dampers, as indicated, in square take-offs.
  - 5. In high pressure duct, branch take-offs and connections to flexible duct supplying air to terminal units shall be made with conical taps.

3.8 IMPROPER MATERIALS OR CONFIGURATION

- A. If ductwork materials or ductwork configurations are installed which do not meet these specifications, Contractor shall remove such ductwork and replace with materials or configurations which are acceptable. Any delay in job progress will be the responsibility of the Contractor.

3.9 OTHER REQUIREMENTS

- A. Insulated Duct: Where ducts will be insulated, make provision for neat insulation finish around damper operating quadrants, splitter adjusting clamps, access doors, and similar operating devices. A metal collar equivalent in depth to insulation thickness and of suitable size to which insulation may be finished shall be mounted on duct.
- B. Control Devices: Properly install all control related devices which are part of the duct systems. See Section(s) describing control systems.

3.10 SEALING OF DUCTS

- A. Duct seal classes are as follows:
1. Seal class "A": Seal all transverse joints, longitudinal seams and duct wall penetrations. Use for P/VC-4 (4" w.g.) and greater unless otherwise indicated.
  2. Seal class "B": Seal all transverse joints and longitudinal seams. Use for P/VC-3 (3" w.g.) unless otherwise indicated.
  3. Seal class "C": Seal all transverse joints. Use for P/VC-2 (2" w.g.) and lower unless otherwise indicated.
- B. Where sealing is required it shall mean the following:
1. The use of adhesives, gaskets, tape systems or combinations thereof to close openings in the surface of the ductwork and field-erected plenums and casings through which air leakage would occur; or
  2. The use of continuous welds;
  3. The prudent selection and application of sealing methods by fabricators and installers, giving due consideration to the designated pressure class, pressure mode (positive or negative), chemical compatibility of the closure system, potential movement of mating parts, workmanship, amount and type of handling; cleanliness of surfaces, product shelf life, curing time and manufacturer-identified exposure limitations;
  4. That these provisions are applicable to duct connections to equipment and to apparatus but are not for equipment and apparatus;
  5. That where distinctions between seams and joints are made herein, a seam is defined as joining of two longitudinally (in the direction of air-flow) oriented edges of duct surface material occurring between two joints. Helical (spiral) lock seams are exempt from sealant requirements. All other duct surface connections made on the perimeter are deemed to be joints. Joints are inclusive of but not limited to girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum and casing abutments to building structures; that sealing requirements herein do not contain provisions to:
    - a. Resist chemical attack.
    - b. Be dielectrically isolated.
    - c. Be waterproof, weatherproof or ultraviolet ray resistant.
    - d. Withstand temperatures higher than 120°F or lower than 40°F.
    - e. Contain atomic radiation or serve in other safety-related construction.
    - f. Be electrically grounded.
    - g. Maintain leakage integrity at pressures in excess of the duct classification herein.
    - h. Be underground below the water table.
    - i. Be submerged in liquid.
    - j. Withstand continuous vibration visible to the naked eye.
    - k. Be totally leak-free within an encapsulating vapor barrier.
    - l. Create closure in portions of the building structure used as ducts, e.g., ceiling plenums, shafts, pressurized compartments.
  6. The requirements to seal apply to both positive pressure and negative pressure of operation.
  7. Externally insulated ducts located outside of buildings shall be sealed prior to being insulated as though they were inside. If metal surfaces of ducts located on the exterior of buildings are exposed to weather, they shall receive exterior duct sealant. An exterior duct sealant is defined as a sealant that is marketed specifically as forming a positive air and water tight seal, bonding well to the metal involved, remaining flexible with metal movement and having a service temperature range of -30°F to 175°F. If exposed to direct sunlight it shall also be ultraviolet ray and ozone resistant or shall, after curing, be painted with a compatible coating that provides such resistance. The term sealant herein is not limited to materials of adhesive or mastic nature but is inclusive of tapes and combinations of open weave fabric strips and mastics.
- C. Materials and applications for sealing ducts:
1. General:
    - a. Complete product data on all materials used for sealing ducts must be submitted for approval prior to any duct fabrication.
    - b. All sealants must be specifically recommended by their manufacturer for the purpose of sealing ducts.
  2. Liquid Sealant:
    - a. Use only for slip type joints where sealant is to fill small space between overlapping pieces of metal. Do not use where metal clearances exceed 1/32-inch.

- b. Sealant must be specifically manufactured for the purpose of sealing ducts.
3. Mastics:
  - a. Use in lieu of liquid sealant at Contractor's option.
  - b. Use as a fillet, in grooves and between flanges.
  - c. Do not use oil base caulking or glazing compounds.
4. Gaskets:
  - a. Use soft elastomer butyl or neoprene rubber or extruded forms of sealants in flanged joints in addition to mastic.
5. Tape:
  - a. Tape is not allowed on sheet metal ducts.
6. Combination of mastic and embedded fabric:
  - a. Use mastic/mesh/mastic as a sealant where pressure/velocity classification equals and exceeds P/VC-3 and where any spaces between metal surfaces at transverse joints or longitudinal seams or duct wall penetrations exceeds 1/16-inch.
  - b. Apply glove coat of mastic, then embed a continuous or overlapping strip of not less than 4-inch wide 10 x 10 fiberglass cloth into the mastic, then apply a final glove coat of mastic over the glass cloth.
7. Surface preparation:
  - a. Surfaces to receive sealant should be adequately clean (free from oil, dust, dirt, rust, moisture, ice crystals and other substances that inhibit or prevent bonding). Use solvent and/or apply a face primer if necessary to obtain adequately clean surface for adhesion.

### 3.11 LEAKAGE TESTING

#### A. General:

1. Test the following duct systems:
  - a. All ducts which are (1) under positive or negative pressure and (2) which are directly connected to air moving device (air handling unit, exhaust fan, supply fan or similar air moving equipment) and (3) which convey 1000-cfm or greater through their largest portion.
  - b. All ducts which are (1) under positive or negative pressure and (2) which are part of a supply, return, outside and/or exhaust air system and (3) which are equal to or greater than 25 feet in length and (4) which may or may not be directly connected to an air moving device.
2. Portions of duct to be tested shall consist of all portions from the largest cross sectional area to the air distribution device connection or to the smallest inlet or outlet point, whichever is applicable.
3. Duct systems shall be constructed so that leakage does not exceed 5.00% of the air quantity handled by the respective fan.

#### B. Allowable Leakage:

1. Leakage shall be measured during leakage test at a test pressure which is equal to the pressure/velocity classification of the duct system (e.g., a P/VC-2 duct shall be tested at 2.0 in. w.g.s.p., a P/VC-1/2 duct at 0.5 in. w.g.s.p., etc.).

#### C. Test Procedure:

1. Test at time of duct installation and prior to installation of any field applied insulation and prior to any concealment in chases or similar enclosures.
2. Duct openings (both entry openings and outlet openings) shall be capped or sealed by taping or banding a flexible plastic sheet over each opening prior to pressurizing duct. The plastic sheet shall be of adequate strength and thickness to withstand the test pressures. Use other method of sealing duct openings providing objective of test is obtained and if method of sealing is approved by Architect/Engineer.
3. Use a fan having a minimum capacity of 300-cfm or 5% of the particular duct system design capacity, whichever is greater and which is capable of producing a duct test pressure of 150% of the duct test pressure.
4. Test fan shall be connected to a flow measuring assembly consisting of straightening vanes and an orifice plate mounted in a straight tube with appropriately located pressure taps. Orifice assembly shall be accurately calibrated with its own calibration curve. Pressures shall be measured with U-tube manometers and corresponding flow rates obtained from the orifice performance curve.

5. Connect test fan and orifice flow measuring assembly to the duct to be tested with a section of flexible duct.
6. Test for audible leaks as follows:
  - a. Close off and seal all openings in the duct section to be tested. Connect the test apparatus to the duct by means of a section of flexible duct.
  - b. Start the blower with its control damper closed (some small blowers popularly used for testing ducts may damage the duct because they can develop pressures up to 25 inches (W.G.).
  - c. Gradually open the inlet damper until the duct pressure reaches 50% in excess of designed duct operating pressure.
  - d. Survey all joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealing has been repaired if and where necessary.
7. After all audible leaks have been sealed, the leakage should be measured with the orifice section of the test apparatus as follows:
  - a. Start blower and open damper until pressure in duct reaches 25% in excess of designed duct operating pressure.
  - b. Total allowable leakage shall not exceed five (5) percent of the total system design air flow rate. When partial sections (such as supply section, return section, etc.) of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
8. Correct any duct leaks which are detected either audibly or by touch regardless of whether leakage through duct system is less than allowable test leakage.

### 3.12 DEFINITIONS OF DUCT TYPES

- A. Refer to the "Duct Type and Location Schedule" on the Drawings for:
  1. The type of ductwork and where it is to be installed.
  2. The pressure/velocity class at each location.
  3. Indication of whether the ductwork is to be insulated externally or internally lined or not insulated.

END OF SECTION

**SECTION 23 33 00**

**DUCT SYSTEM ACCESSORIES**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide all necessary duct system accessories to assure proper balance, quiet and draftless distribution and conveyance, and minimization of turbulence, noise and pressure drop for all supply return, exhaust and ventilation air quantities indicated.
- B. Items Included: This section generally includes, but is not limited to, the following items as may be applicable to this project:
  - 1. Flexible duct connections.
  - 2. Splitters.
  - 3. Turning vanes.
  - 4. Manual volume dampers.
  - 5. Access doors.
  - 6. Fire Dampers.
  - 7. Smoke Dampers.
  - 8. Fire/Smoke Dampers.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.
- B. This section directly relates in particular to sections (which may or may not be included in this division) which describe the following:
  - 1. Ductwork.
  - 2. Air distribution devices.
  - 3. All types of air handling equipment.

1.4 COORDINATION

- A. Coordinate all items affecting the duct systems including but not limited to the following items: air handling units, exhaust fans, supply fans, sound attenuators, duct mounted coils, access panels air distribution devices, fire dampers, outside air louvers, hoods, filters, roof curbs, structural framing, roof construction, roofing, and the work of all trades to insure an orderly and timely progression of the work.

1.5 SHOP DRAWINGS

- A. Include complete data on: access doors; flexible connectors; manual volume dampers including operating hardware; turning vanes; automatic shutters and all other items.
- B. See section entitled, "General Mechanical Provisions".

1.6 OTHER REQUIREMENTS

- A. Provide all components in accordance with manufacturer's recommendations.
- B. All ductwork dimensions indicated which may affect items of this section are nominal free clearance internal dimensions which do not include insulation thickness.

1.7 DEFINITIONS

- A. "SMACNA" means "Sheet Metal and Air Conditioning Contractors National Association, Inc.".

**PART 2 - PRODUCTS**

2.1 GENERAL

- A. Be recommended by the manufacturer for the application.
- B. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:
  - 1. Ventfabrics
  - 2. Barber-Colman
  - 3. Tuttle & Bailey
  - 4. Dura-Dyne
  - 5. Airsan
  - 6. Titus
  - 7. Anemostat
  - 8. Young
  - 9. Metalaire
  - 10. United McGill
- C. Products which are specified may not necessarily all be required on the projects; provide those products which are applicable.

2.2 FLEXIBLE DUCT CONNECTIONS

- A. Provided where air handlers, fans and blowers connect to their ductwork.
- B. At least 4 inches long.
- C. Connected on each side to metal (either metal ductwork, air handling apparatus, or heavy gauge steel sleeves).
- D. For use in high and/or low pressure duct systems.
- E. Ventfabrics, Inc., "Ventglas Metaledge", or equivalent.

2.3 SPLITTERS

- A. Provide for adjustment of air volume to their respective branches, where indicated. Constructed of at least the same gauge galvanized steel as the duct wherein they are used, and in no instance be less than twenty-two (22) US gauge. Use in low pressure duct systems only. Be adequately sized to close off air to applicable branches. Rigidly attached to pivot rod and operating linkage. Install on raised insulated base when used in internally insulated ductwork. Splitter blades; formed in two thicknesses of metal so that entering edge presents rounded nose to air flow; length no less than one and one half times the width of the smaller branch served or twelve inches, whichever is larger. Hardware used for the construction, assembly, and operation of splitter dampers shall be as follows:
  - 1. Operators for exposed splitters and those located above "lay-in" or accessible ceiling shall be Ventlok #690 splitter damper assembly.
  - 2. Operators for concealed splitters shall be Ventlok #691 with #680 miter and #677 concealed regulator.

2.4 LOW PRESSURE METAL TURNING VANES

- A. Provide in all elbows, bends and tees of all low velocity supply air ducts whether or not shown in detail; provide in all elbows, bends and tees of all other low velocity ducts where portions of such ducts convey air at greater than 700 fpm average velocity. Adequate rigidity and strength to be completely flutterproof; properly designed; permanently fixed type. Aluminum, or steel with acid/solvent chemical corrosion resistant coating, or galvanized steel. Air foil type in all mitered elbows, mitered bends and tees. Air foil type must be manufactured by Titus, Tuttle & Bailey, Anemostat, Waterloo, Metalaire, Barber-Colman or other approved manufacturer. Be Barber-Colman "Airturns", Tuttle and Bailey "Ducturns", or Dura-Dyne "VR" with 24 gauge rails and hollow vanes, or equivalent.

2.5 HIGH PRESSURE TURNING VANES

- A. None required for this project.

2.6 MANUAL VOLUME DAMPERS

- A. These dampers are to be other than those specified as being integral with each register, diffuser and other air outlet or inlet.
- B. Provided where indicated in the complete air distribution system(s) (including ductwork, return air plenums, etc.) to allow complete balancing of the air supply, return, ventilation and exhaust system(s).
- C. Opposed blade type.
- D. 8" maximum blade width.
- E. Made of galvanized steel, steel with acid/solvent chemical resistant coating, or steel with a sprayed or dipped aluminum rust resistant finish; flutterproof.
- F. Provided so that all damper adjustment can be made from outside the completed ductwork without necessity for puncturing or otherwise penetrating the ductwork and/or its vapor barrier.
- G. Fully adjustable and with locking device.
- H. Manufactured by Titus, Tuttle & Bailey, Anemostat, Waterloo, Metalaire, Greenheck or equivalent.
- I. Provided at a point in the ductwork which is a sufficient distance upstream from an outlet (or downstream from an inlet) to attenuate objectionable noise due to damper throttling and to preclude adverse effects on the distribution device.
- J. Based upon location of the duct in which the damper is to be installed, provide the following types:
  - 1. Dampers in ducts which are exposed or located above "lay-in" or "accessible ceilings": Young Regulator Company Model 817 or equivalent.
  - 2. Dampers in ducts concealed above plaster ceilings or behind dry wall construction: Young Regulator Company Model 817A or equivalent.
- K. Use in low pressure duct system only.

2.7 LOW PRESSURE DUCT ACCESS DOORS

- A. Provided for: each manual and motorized damper; fire damper; smoke damper; electric duct heater; and where access is otherwise necessary.
- B. Factory prefabricated double wall insulated type of 24 US gauge galvanized steel (of same or thicker gauge than ductwork panel in which installed, whichever is greater).
- C. Minimum size shall be as large as is compatible with duct size but in no case less than the following (provide larger sizes if necessary to permit proper access operation):

<u>Max. Duct Dimensions</u>	<u>Access Door Size</u>
11" and less	10" x 12"
12" through 16"	12" x 16"
17" and over	16" x 24"

- D. Doors shall be provided with and operated adjustable tension catches and shall be completely gasketed around their perimeters. Doors shall be Ventlok "Access Doors". Install in accordance with manufacturers recommendations using Ventlok #360 sealant or equivalent.

2.8 TEST OPENINGS

- A. Furnish and install gasketed capped test openings for test equipment (pitot tubes, etc.) on the entering and leaving sides of air handling unit and other air handling equipment and heating coils. Test openings shall be Ventlok #699-2 or equivalent.



2.9 PREFABRICATED DUCT CONNECTIONS

- A. At Contractor's option, prefabricated duct connections as manufactured by Ductmate (or approved equal system) may be used in locations and applications for which the duct connection system is recommended. Use of these connections must meet or exceed specified duct construction quality as related to structural rigidity, pressure, accessibility and other such requirements.

2.10 FIRE DAMPERS

- A. Rating: 1-1/2 hours (UL approved for installation in 2 hour walls).
- B. Construction: Minimum 24 gauge galvanized steel frame suitable for connection to ductwork without transition, minimum 24 gauge galvanized steel curtain type blades located out of the airstream, thickness coordinated with wall construction. Where an active smoke control system exists (refer to Section 23 09 93) the damper shall be capable of closing in an airstream moving at a minimum of 2000 feet per minute and operating at 4" w.g. pressure (dynamic damper).
- C. Sleeves: UL listed minimum gauge galvanized steel with welded construction corners. Rollformed sleeves will not be acceptable unless contractor guarantees in writing to seal voids in sleeve with UL approved sealer to limit air leakage. Length of sleeve shall be coordinated with the wall or floor.
- D. Operation: Stainless steel constant force closure spring.
- E. Link Setting: 160°F or 165°F.
- F. Based on Ruskin Manufacturing Co. IBD2 Style B. (Static Systems).
- G. Based on Ruskin Manufacturing Co., DIBD2 Style B. (Active smoke control systems only).

2.11 SMOKE DAMPERS

- A. Low and Medium Pressure Ductwork:
  - 1. UL labeled under UL 555S low leakage rated, no more than 10 CFM/SF @ 1" w.g. (UL Class II) after exposure to 1000°F for 1 hour (non-degradable). Classified for both horizontal and vertical mounting.
  - 2. Construction:
    - a. Frame 16 galvanized steel.
    - b. Damper Blades: 14 gauge true airfoil design constructed of galvanized steel of low leakage non-heat degradable design with friction free silicone rubber edge type for a smoke seal to 450°F incorporated into blade and frame shapes. Blade shall be suitable for installation in systems with a maximum velocity of 4,000 FPM and 8" w.g. pressure at closure.
  - 3. Damper operation by means of an electric actuator 120V AC, 24V AC or signal from smoke detector alarm circuit. Electric motor actuator to be UL listed with damper assembly for power open, spring closed operation with a maximum travel time of 15 seconds. Motor furnished with all connecting linkage and mounting hardware.
  - 4. Damper and actuator shall be provided with a 60 month warranty.
  - 5. Based on Ruskin Manufacturing Co., SD60-II.

2.12 SMOKE/FIRE DAMPERS

- A. Low and Medium Pressure Ductwork:
  - 1. UL labeled under the following standards:
    - a. UL 555 - 1-1/2 hr. fire endurance.
    - b. UL 555S - Low leakage rated, no more than 10 CFM/SF @ 1" w.g. (UL Class II) after exposure to 1000°F for 1 hour (non-degradable).
    - c. Classified for both horizontal and vertical mounting.
  - 2. Construction: Single damper designed and rated for combination smoke/fire duty.
    - a. Frame: 16 ga. galvanized steel.
    - b. Damper Blades: 14 gauge true airfoil design constructed of galvanized steel of low leakage non-heat degradable design with friction free inflatable silicone coated fiberglass material to maintain smoke leakage rating to a minimum of 450°F and galvanized steel for flame seal to 1900°F. Blade shall be suitable for installation in systems with a maximum velocity of 2,000 FPM and 4" w.g. pressure at closure.

c. Duct sleeve provided by others.

3. Operation:

- a. Smoke/fire damper operation by means of an integral resettable and re-useable UL listed electric-ambient temperature link, UL listed releasing device and mechanical lock assembly. Link activated by either electric, 120V AC or 24V AC signal from smoke detector alarm circuit or 350°F duct ambient temperature. Damper shall be capable of being reopened by remote signal when the duct temperature drops to 150°F. Electric motor actuator shall be UL listed with the damper assembly for power open/spring closed operation. Motor actuator shall be factory furnished with all connecting linkage and mounting hardware and shall be factory tested for proper operation.
- b. Damper and actuator shall be provided with a 60 month warranty.

4. Based on Ruskin Manufacturing, Co., FSD60-2.

2.13 BACKDRAFT DAMPERS

A. Low Pressure Ductwork:

1. Rating: Up to 1" wg positive or negative.
2. Frame: Minimum 16 gauge (.064") galvanized steel or extruded aluminum.
3. Blades: Minimum 16 gauge (.064") galvanized steel or extruded aluminum parallel blade action, brass bearing, non-ferrous or de-iron pivot pins, gasketed blades.
4. Accessories: Counter balance and weights suitable for assisting or retarding as indicated on the drawings.
5. Based on Ruskin Manufacturing, Co. CBD4.

**PART 3 - EXECUTION**

3.1 GENERAL

- A. Construct and install all accessories in accordance with the latest indicated editions of applicable SMACNA construction standards.
- B. Provide all mitered elbows with turning vanes.
- C. Install all duct system accessories in accordance with manufacturer's recommendations.
- D. All accessories installed in poly-vinyl-steel ductwork shall have acid/solvent chemical corrosion resistant coating.
- E. All manual damper arms shall be tagged with fluorescent colored strip.

3.2 FIRE DAMPERS

- A. Fire dampers shall be provided where indicated.
- B. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.
- C. All fire dampers shall be mounted within a UL approved thickness galvanized steel sleeve permanently affixed to the wall by means of perimeter retaining angles.
- D. The fire damper shall be permanently attached to the sleeve. All voids around the sleeve and damper and sleeve and wall shall be properly sealed with fire barrier material, refer to division 07.
- E. Ductwork shall be attached to the fire damper by means of a UL approved break away connection.
- F. Access doors or access sections shall be provided at all fire damper locations.

3.3 SMOKE DAMPERS

- A. Provided where indicated. See combination smoke/fire damper for assemblies in fire rated barriers.
- B. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.

- C. Provide access doors or access sections at all damper locations.
- D. Coordinate the provision of the smoke damper actuator with the automatic temperature control and fire alarm system and ensure adequate space for the mounting of the actuator during installation of the damper and ductwork.

#### 3.4 SMOKE/FIRE DAMPER

- A. Provided where indicated. All smoke dampers in fire rated barriers to be combination type.
- B. Review the architectural drawings to determine the wall construction rating so as to provide the proper rated damper.
- C. All smoke/fire dampers shall be mounted within a UL approved thickness galvanized steel sleeve permanently affixed to the wall by means of perimeter retaining angles.
- D. The smoke/fire damper shall be permanently attached to the sleeve. All voids around the sleeve and damper and sleeve and wall shall be properly sealed with fire barrier material, refer to division 07.
- E. Ductwork shall be attached to the smoke/fire damper by means of a UL approved break away connection.
- F. Access doors or access sections shall be provided at all smoke/fire damper locations.
- G. Coordinate the provision of the smoke damper actuator with the Building Control System and assure adequate space for the mounting of the actuator during installation of the smoke/fire damper and ductwork.

#### 3.5 BACKDRAFT DAMPER

- A. Securely attach backdraft damper to wall with a suitable sleeve and retaining angles and seal all voids between damper and wall.
- B. Adjust damper to open or close under the design conditions.

END OF SECTION

**SECTION 23 34 29**

**FANS: CENTRIFUGAL, CEILING MOUNTED**

**PART 1 - GENERAL**

1.1 SCOPE

A. Provide ceiling mounted light duty centrifugal fans with characteristics indicated.

1.2 SHOP DRAWINGS

A. Refer to requirements of Section entitled "General Mechanical Provisions".

1.3 CERTIFIED PERFORMANCE

A. Be AMCA certified as to both sound and performance ratings.

1.4 MANUFACTURER

A. Design Basis: Basis of design is similar to Acme Master-ette Model V Series and Greenheck CSP Series or as scheduled on drawings.

B. Acceptable Manufacturers: Greenheck Fan and Ventilator Corporation; Loren Cook Company; Captive Aire or equal.

**PART 2 - PRODUCTS**

2.1 FAN HOUSING

A. Fan housing including longitudinal, traverse, and diagonal stiffeners, motor mounts, bearing and drive supports shall be constructed of steel. Entire fan housing shall be internally lined with ½-inch thick or greater, three pound per cubic foot density fiberglass acoustical duct liner with a stabilized surface. Liner shall be held in place with adhesive and mechanical fasteners. All insulation and adhesives shall meet requirements of NFPA 90A as to flame spread and smoke developed ratings. Housing, including all bracing, stiffeners and motor mounted assembly shall be factory finished with a baked on alkyd enamel finish over a corrosion resistant primer. Removable panel in bottom of housing for complete access to motor and fan.

2.2 CEILING INLET GRILLE

A. Steel or aluminum: Baked enamel finish.

2.3 FAN WHEEL

A. Shall be centrifugal type and shall be statically and dynamically balanced. Single or twin impeller as necessary to provide indicated performance.

2.4 FAN MOTOR

A. Permanently lubricated shaded pole motor mounted on resilient isolators to minimize vibration and noise.

2.5 BACK DAMPER

A. Mounted in throat of fan discharge.

2.6 DRIVE ASSEMBLY

A. Drive shall be direct drive type as indicated on drawings, and shall conform with the requirements of Section entitled "General Mechanical Provisions".

2.7 DISCONNECT SWITCH

- A. Fans shall include factory mounted disconnect switches prewired to the drive motor.

2.8 SPEED CONTROL

- A. Solid state speed controller for speed reduction to 40% Mounted on housing or as otherwise indicated.

**PART 3 - EXECUTION**

3.1 PLACEMENT AND MOUNTING

- A. Fan locations shall be essentially as shown on drawings; however, actual fan placement shall be verified using field measurements and data relating to equipment approved for actual installation on this project. Mount fan in strict accordance with manufacturer's instructions.

3.2 TEST AND BALANCE

- A. All fan performance shall be certified by test and balance procedures as specified in section describing test and balance procedures.

END OF SECTION

**SECTION 23 37 13**

**AIR DISTRIBUTION DEVICES**

**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-01 Specification sections, apply to work of this section.

1.2 SCOPE

- A. Provide all air distribution devices as indicated on the drawings and as specified herein for a complete and operable system.

1.3 RELATION TO OTHER WORK

- A. Refer to the section, "General Mechanical Provisions", for related requirements. Refer to other sections of Division 23 and to all other applicable portions of the Drawings and Specifications.

- B. Coordinate with work of the ceiling, drywall and plastering trades as required to insure an orderly progression of work and a first class finished system with respect to placement, alignment, finish, general fit and absence of conflict with lighting systems and fire protection systems.

Insulate air distribution devices to prevent condensation formation.

1.4 DESIGN CONDITIONS

- A. Acoustical: Noise produced at each diffuser, register, grille or other air distribution device shall not exceed a noise criteria level of NC 35 based on sound pressure levels in db re 0.002 microbars unless otherwise indicated. Coordinate air distribution devices, sound attenuation measures and equipment actually provided to insure that this design constraint is not exceeded by the system installed.

Exceptions: Any particular rooms or areas which are normally occupied by other than maintenance staff or service staff and which may be noted on the drawings as requiring lower NC criteria.

- B. Pressure Drop: Pressure drop across any air distribution device shall not exceed 0.15 in wg static pressure unless otherwise indicated.

1.5 SHOP DRAWINGS

- A. Refer to the requirements of Section entitled "General Mechanical Provisions".

1.6 MANUFACTURER

- A. Products listed in this Section or on the plans are based on a specific manufacturer to establish the desired style, quality and type. Equivalent products, complying with the requirements of this Section and the installation requirements of the plans, by the following manufacturers are acceptable:

1. Titus
2. Metalaire
3. Price

- B. Manufacturers must be members of the Air Distribution Council unless otherwise indicated.

1.7 OTHER REQUIREMENTS

- A. All aluminum is to be extruded unless otherwise indicated.

- B. Appearance: Each air distribution device which has a portion thereof (frame, core, etc.) exposed to view in the finished area shall have a factory applied finish which matches and is compatible with the color of

the surrounding surface on which the device is installed. Colors must be approved by Architect prior to device fabrication.

- C. All louvers, dampers and/or shutters shall be rated by their manufacturer in accord with AMCA Standard 500-74.
- D. Integral Components: All dampers, blank-off baffles and other companion devices which form an integral part of air distribution device shall be factory made items produced by the manufacturer of air distribution device.
- E. Louvers: Louvers may be specified in another division but for reference may also be indicated on mechanical drawings.
- F. Door Grilles: Door grilles may be specified in another division but for reference may also be indicated on mechanical drawings.

## **PART 2 - PRODUCTS**

### 2.1 GENERAL

- A. Provide the following air distribution devices as applicable to this project. Refer to air distribution device schedule as shown on drawings.

### 2.2 OTHER REQUIREMENTS

- A. All devices must each comply with the applicable portions of the Air Diffusion Council (ADC) Equipment Test Code 1062R4 "Certification, Rating and Test Manual", the Air Movement and Control Association, Inc. (AMCA) Standard 500 "Test Method for Louvers, Dampers and Shutters" and the "National Fire Protection Association" (NFPA) Standard 90A "Installation of Air Conditioning and Ventilating Systems".
- B. Provide ceiling and/or linear diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of diffuser.
- C. Diffusers, grilles and registers installed in fire rated ceiling, or floor/ceiling assemblies shall be constructed of steel.
- D. Mounting Screws: Where grilles, diffusers or registers are specified which require mounting screws visible from the face of the device these screws shall be furnished with the air distribution equipment and be finished at the factory to match the finish on the grille, diffuser or register in which they are to be used.

## **PART 3 - EXECUTION**

### 3.1 GENERAL

- A. Install neatly where indicated in accord with manufacturer's recommendations and in accord with SMACNA recommendations and as otherwise indicated.
- B. Properly test, balance and adjust to produce quiet, draftless operation to best degree possible.

### 3.2 INSTALLATION

- A. Rectangular Diffusers: Where diffusers are the lay-in type, they shall be supported by the inverted T-bar suspension system but all ducts connected thereto shall be supported independently of the ceiling as specified under Section entitled "Ductwork". Surface mounted diffusers shall be supported by the duct runouts or drops where sheet metal ducts are indicated and by separate hangers where flex runouts are indicated. All rectangular ceiling diffusers shall be installed with their lines parallel and perpendicular to the building line and properly aligned with the ceiling.
- B. Sidewall Grilles and Registers: Mount securely to the duct system flanges using finish screws and in accordance with accepted good practice.

- C. Ceiling mounted Exhaust and Return Registers/Grilles: Mount as specified hereinbefore for surface mounted ceiling diffusers except use finished screws provided and secure to duct and finished ceiling (or finished ceiling for nonducted returns) in accordance with the manufacturer's instructions. Where required to provide adequate support for nonducted registers or grilles, provide appropriate mounting frame for incorporation into the ceiling system.
- D. Install all outlets and inlets as recommended by the manufacturer; in accordance with recognized industry practices; to insure that products serve intended functions.
- E. Locate ceiling air outlets and inlets as indicated on the drawings. Unless otherwise indicated, locate units in center of acoustical ceiling modules. Install square and parallel with partitions, ceiling grid members, etc.
- F. Spare Parts: Furnish to Owner, with receipt, 3 operating keys for each type of outlet and inlet that require them.
- G. Do not install blank-offs under continuous linear diffuser distribution plenums. Distribution plenums shall cover only active portion of the diffuser.

### 3.3 PROTECTION OF WORK UNTIL FINAL ACCEPTANCE

- A. Coordinate the installation of the air distribution equipment with related work and finishing of adjacent surfaces to prevent damage to the devices or adjacent finishes. Protect the finish of all air distribution equipment until final acceptance. Replace or repair to the Architect's satisfaction any damaged equipment.

END OF SECTION



**SECTION 23 43 24**

**AIR PURIFICATION SYSTEM**

**PART 1 - GENERAL**

1.1 DESCRIPTION OF WORK

- A. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer's air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.

1.2 REFERENCED CODES AND STANDARDS

- A. The following codes and standards are referenced through out. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.
  - 1. ASHRAE Standards 62 & 52
  - 2. National Electric Code NFPA 70
  - 3. UL 867

1.3 RELATED WORK

- A. Testing, Adjusting and Balancing
- B. Facility Access and Protection
- C. Ductwork
- D. Filters
- E. Water and Refrigerant Piping
- F. Electrical Wiring
- G. Control Wiring

1.4 QUALITY ASSURANCE

- A. The Air Purification System shall be a product of an established manufacturer within the USA.
- B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.
- C. Technologies that do not address gas disassociation such as UV Lights, Powered Particulate Filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. "Plasma" particulate filters shall not be acceptable.
- D. Projects designed using ASHRAE Standard 62, IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled with the technology submitted. The manufacturer shall provide independent test data on a previous installation in a similar application, that proves compliance to ASHRAE 62 and the accuracy of the calculations.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for ion generators including:
  - 1. Schedule of plasma generators indicating unit designation, number of each type required for each unit/application.
  - 2. Data sheet for each type of plasma generator, and accessory furnished; indicating construction, sizes, and mounting details.
  - 3. Performance data for each type of plasma device furnished.

4. Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled (when projects are designed with outside air reduction).
5. Product drawings detailing all physical, electrical and control requirements.

B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.

#### 1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.
- B. Store in original cartons and protect from weather and construction work traffic.
- C. Store indoors and in accordance with the manufacturers' recommendation for storage.

#### 1.7 WARRANTY

- A. Equipment shall be warrantied by the manufacturer against defects in material and workmanship. This guarantee shall be by the Contractor to the Owner to replace for the Owner any defective workmanship, equipment, or material which has been furnished under this Contract at no cost to the Owner for a period of one year from the date of acceptance of the System at Substantial Completion.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL

- A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and shall be of the manufacturers specified.
- B. Acceptable Manufacturers: Plasma Air, Global Plasma Solutions, Bioclimatic.
- C. All other Suppliers of comparable products requesting prior approval shall:
  1. Submit for prior approval in accordance with the requirements of Section 230100.
  2. In addition, manufacturers submitting for prior approval for Bi-Polar Ionization must as part of the prior approval request provide their ASHRAE 62.1-2007 calculations that prove conformance to the ASHRAE Standard with the reduction of outside air to the scheduled values. A letter on the manufacturer's letterhead requesting prior approval must accompany the request for prior approval stating their calculations are ASHRAE compliant. A third party validation study performed on a previous installation of the same application shall also be included.

#### 2.2 BI-POLAR IONIZATION DESIGN AND PERFORMANCE CRITERIA

- A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.
- B. The Bi-polar Ionization system shall be capable of:
  1. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
  2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
  3. Capable of reducing static space charges.
  4. Effectively reducing space particle counts.
- C. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable.
  1. Air exchange rates may vary through the full operating range of a constant volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system. Velocity Profile: The air purification device shall not have maximum velocity profile.
- D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system.

- E. Equipment Requirements:
  - 1. Electrode Specifications (Bi-polar Ionization):
    - a. Each Plasma Generator with Bi-polar Ionization output shall include the required number of electrodes and power generators sized to the air handling equipment capacity. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, performance output reduction over time, ozone production and corrosion.
    - b. Electrodes shall be energized when the main unit disconnect is turned on and the fan is operating.
    - c. Manufacture shall demonstrate that no voltage potential exists due to exposed electrical components.
- F. Air Handler Mounted Units:
  - 1. Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and associated power supplies. All interconnecting wiring shall be UL and NEC NFPA 70 approved. Electrical contractor shall provide a 120Volt circuit to the ion generators.
- G. Ionization Requirements:
  - 1. Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.
    - a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by 110VAC to 208VAC to 240VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.
    - b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced. Imbalanced levels shall not be acceptable.
    - c. Ionization output from each electrode shall be a minimum of 15 million ions/cc when tested at 2" from the ionization generator.
  - 2. Ozone Generation:
    - a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation.
- H. Electrical Requirements:
  - 1. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 115 VAC to 240VAC, 1 phase, 50/60 Hz.
- I. Control Requirements:
  - 1. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.
  - 2. The installing contractor shall mount and wire the Plasma device within the air handling unit specified or as shown on the plans. The contractor shall follow all manufacturer IOM instructions during installation.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

#### **3.2 ASSEMBLY AND ERECTION: PLASMA GENERATOR WITH BI-POLAR IONIZATION**

- A. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and engineer.
- B. Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.
- C. All equipment shall be protected from dust and damage on a daily basis throughout construction.

#### **3.3 TESTING**

- A. Provide the manufacturers recommended electrical tests.

3.4 COMMISSIONING AND TRAINING

- A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION

**SECTION 23 81 26**

**CONDENSING UNITS: AIR COOLED HERMETIC**

**PART 1 - GENERAL**

1.1 SCOPE

- A. Provide packaged hermetic air cooled condensing units of the capacity, operating characteristics, and electrical characteristics indicated on drawings and specified herein.

1.2 SHOP DRAWINGS

- A. Refer to Section entitled "General Mechanical Provisions". Include complete data on: unit dimensions; minimum operating and service clearances; capacities and rating conditions; maximum operating weights; power consumption; power and control wiring (both factory and field); and operating and safety controls.

1.3 MANUFACTURER

- A. Design Basis: Trane TTA Series or as otherwise scheduled.
- B. Acceptable: Carrier, Trane, York or equal.

1.4 COMPATIBILITY

- A. Each unit must be compatible with evaporator coil arrangements and associated controls to which connected equipment is interfaced.

**PART 2 - PRODUCTS**

2.1 FRAME

- A. Unit shall be completely factory assembled with all components mounted on a steel frame.

2.2 FINISH

- A. The frame, all structural members, and sheet metal panels shall be properly cleaned, painted with a zinc rich primer, and finished with alkyd enamel.

2.3 COMPRESSOR AND MOTOR

- A. The unit compressor(s) shall be of the hermetic reciprocating type with crankcase heater.
- B. Motor shall be suction gas cooled and sized for continuous operation over the full range of operating conditions indicated and with voltage variations indicated in the National Electric Code. Motor running protection shall be provided by temperature sensors embedded in the motor windings and by thermal overload relays.

2.4 CONDENSER

- A. Seamless copper tubes with mechanically bonded aluminum fins.

2.5 CONDENSER FANS

- A. Direct drive, propeller type with fan guards. Fan motors shall have thermal overload relays for running protection.

2.6 FACTORY PREWIRING

- A. Unit shall be factory wired with power connections brought out to a single set of terminal lugs for field connection.

**PART 3 - EXECUTION**

3.1 UNIT PLACEMENT

- A. The unit location shall be essentially as shown on drawings; however, actual placement shall be verified using field measurements and data relating to the equipment approved for actual installation on this project.

3.2 COORDINATION

- A. Refer to Sections describing refrigerant piping systems and air handling units with DX refrigerant coils. Provide all piping, hangers, supports, valves, and specialty items as required for a complete and operable system.

3.3 VIBRATION CONTROL

- A. Refer to Section entitled "Vibration Isolation" for vibration control.

3.4 TEST AND BALANCE

- A. Refer to Sections describing tests and balancing.

END OF SECTION

**SECTION 23 81 27**

**AIR HANDLING UNITS, SPLIT SYSTEM**

**PART 1 - GENERAL**

1.1 SCOPE

- A. Furnish and install medium duty factory packaged air handling units with direct expansion refrigerant coils of the types, sizes, and capacities indicated.

1.2 SHOP DRAWINGS

- A. Refer to Section entitled "General Mechanical Provisions". Include complete performance data at the scheduled operating conditions, dimensions; weights; fan performance curves, airside pressure losses; waterside pressure losses; coil descriptions; and fan discharge and radiated sound power levels, by octave bands, at the stated conditions.

1.3 CERTIFICATION

- A. Equipment performance ratings shall be certified as follows:
  - 1. Fans: AMCA Bulletin 210 or ARI Standard 430.
  - 2. Coils: ARI Standard 210-79.

1.4 MANUFACTURER

- A. Basis of design: Similar to Trane Series TWE or Climate Changer Series, or as scheduled on the drawings.
- B. Acceptable: Carrier, Trane, York, Weatherking.

1.5 COMPATIBILITY

- A. Each unit must be compatible with the condensing units(s) to which it is matched. This includes unit arrangement/configuration, capacity, associated controls, piping and all other connected equipment to which the unit and its components are interfaced.

**PART 2 - PRODUCTS**

2.1 CASING

- A. Unit casings shall be fabricated of mill galvanized steel reinforced with formed "hat" channels or steel angle iron frames and bracing to provide a rigid assembly. Casing shall be provided with removable panels for access to and removal of coils, dampers and fans in external units. Provide hinged access door for access to and removal of fans and drives in internal drive units.

2.2 DRAIN PAN

- A. Unit drain pan shall be of the double wall internally insulated type with welded seams. Drain pan in draw-thru units shall extend under both the fan and coils sections and in blow-thru units under the entire coil and plenum section.

2.3 DIRECT EXPANSION REFRIGERANT COOLING COILS

- A. Provide direct expansion refrigerant cooling coil of copper tubes with aluminum fins mechanically bonded thereto, circuited to provide proper refrigerant velocities, properly matched with compressor-condenser assembly for proper operation, with expansion valves selected for optimum refrigerant flow from 20% to 100% full load.

2.4 ELECTRIC HEATING COILS

- A. Where electric heating coils are shown or scheduled to be integral with the air handling unit, each such coil shall be as follows:

1. Factory assembled and prewired. Heater capacities, sizes and operating characteristics shall be as scheduled on drawings or as indicated in other sections.
2. Meet all applicable requirements of the current NEC.
3. UL listed including all built-in components.
4. Coordinated with the specified requirements of the mechanical system control system.
5. Provided in capacity control steps indicated or scheduled. If not otherwise indicated, heaters over 10 KW shall have heating elements sequenced on and off in 5 KW increments, and shall be wired for 2 stage operation. All heaters shall be equipped with both thermal and current overload devices, and the required heating and cooling system controls.

## 2.5 FANS

- A. Fans shall be individually selected to best suit the air quantities and pressures scheduled. Fans handling less than eighteen thousand (18,000) cubic feet per minute, at four and one-half (4-1/2) inches or less static pressure may be of the forward curved blade centrifugal type. Fans handling eighteen thousand (18,000) cubic feet per minute or more or operating at more than four and one-half (4-1/2) inches static pressure shall be of the backward inclined airfoil blade centrifugal type. All fans shall be double width, double inlet type. Fans and shafts shall be selected to operate not less than twenty-five percent (25%) below their first critical speed, statically and dynamically balanced, and keyed to the shafts. Shafts shall be of the hollow large diameter type with tapered and strengthened ends where they extend entirely through the casing and shall be solid steel for fans having drives within the casing. Shafts shall be turned and shall be ground and polished at bearing and fan mounting points.

## 2.6 BEARINGS

- A. Provide regreaseable ball types selected for an average life of 200,000 hours at design operating conditions. Bearings shall have grease line extended to the drive side of the fan casing of the drive side of the fan scroll for internal drive fans.

## 2.7 DRIVES AND MOTORS

- A. Provide guards for internal and external drive fans.

## 2.8 INSULATION

- A. The entire air handling unit casing (including accessory sections), including structural frame and channels shall be insulated from contact with the air stream. Insulate using one inch (1") thick, three (3) pound per cubic foot density fiberglass duct liner having a neoprene stabilized face toward the air stream. The insulation shall be secured using a full coverage insulation and adhesives shall comply with the requirements of NFPA 90A as to flame spread and smoke developed ratings.

## 2.9 FILTERS

- A. See section describing air filters.

## 2.10 OVERALL CONSTRUCTION

- A. Shall be as recommended by the manufacturer for operation at the indicated conditions.

## 2.11 OTHER REQUIREMENTS

- A. Be horizontal or vertical configuration (as applicable).
- B. Cooling coils shall not have face velocities in excess of 500 fpm unless otherwise indicated on drawings schedule (in such case, velocity obtained from drawings schedule shall be upper limit).
- C. Units shall be provided which will perform as indicated with proper consideration of any correction factors which are applicable to system unit casing configuration.
- D. Heating coils, if required, shall be located in reheat position unless otherwise indicated.



**PART 3 - INSTALLATION**

3.1 EQUIPMENT PLACEMENT

- A. Air handling equipment shall be located essentially as shown on drawings; however, actual placement of the unit shall be verified using field measurements and data relating to the units approved for actual installation on this project.

3.2 WIRING

- A. Where units utilize internal drives, conduit penetrations shall be provided by the manufacturer. The conduit openings shall be located on the drive side and positioned so as not to compromise access to any portion of the unit. The opening shall be provided with effective seals and the edges of the internal insulation shall be properly sealed.

3.3 SOUND AND VIBRATION CONTROL

- A. Refer to other sections for airside sound control and vibration control. Mount isolators using height saving brackets where required to reduce operating height of unit to suit space available.

3.4 DUCT CONNECTIONS

- A. Supply and return ducts and combination filter mixing boxes shall be connected to their respective air handler using flexible connectors. Connectors shall be properly installed so that they are not in tension and are aligned with their respective ducts.

3.5 HOUSEKEEPING PAD

- A. Provide 6 inch high reinforced concrete (with 10 x 10 WWP) housekeeping pad for each floor mounted unit. The housekeeping pad shall extend 6 inches beyond the unit base in all directions and shall be continuous beneath the base. Pads shall have chamfered edges and shall be poured and finished smooth and level.

3.6 OTHER REQUIREMENTS

- A. Properly connect all piping.
- B. Allow adequate space for all service and operational clearances necessary.

END OF SECTION

**SECTION 26 01 00**

**BASIC ELECTRICAL REQUIREMENTS**

**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 work of this Section.
- B. Coordination of work between mechanical and electrical trades is covered in Division-23 Section "GENERAL MECHANICAL PROVISIONS".

1.2 SUMMARY

- A. This Section specifies the basic requirements for electrical installations and includes requirements common to all sections of Division-26. It expands and supplements the requirements specified in sections of Division-01.

1.3 CODES AND STANDARDS

- A. Install all work in accordance with the applicable requirements of the following:
  - 1. 2014 National Electric Code (NEC)
  - 2. Local, State, County and City Codes
  - 3. National Fire Protection Association (NFPA)
  - 4. American National Standards Institute (ANSI)
  - 5. NEMA Standards
- B. It is the intent of the Contract Documents to comply with the applicable codes, ordinances, regulations, and standards. Where discrepancies occur, notify the Architect in writing, and ask for interpretation. Correct any installation that fails to comply with the applicable codes and standards at no additional cost to the Owner.
- C. All materials shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available for certain types of equipment, test data shall be submitted to prove to the Engineer that equipment meets or exceeds available standards.

1.4 PERMITS AND INSPECTIONS

- A. Obtain and make all payments for permits and inspections required. At the completion of the project and before final acceptance of the electrical work, provide evidence of final inspection and approval by the authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical products specified, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with electrical work similar to that required for this project.

1.6 IDENTIFICATION

- A. The following items shall be equipped with nameplates: All motors, motor starters, motor-control centers, pushbutton stations, control panels, time switches, disconnect switches, panelboards, circuit breakers, contactors.
- B. Nameplates shall adequately describe the function of the particular equipment involved. Nameplates for panelboards and switchboards shall include the panel designation, branch (normal or emergency), voltage and phase of the supply. For example, "Panel A, Emergency Branch, 480Y/277V, 3-phase, 4-wire."

- C. Nameplates shall be laminated phenolic plastic, black front and back with white core, with 3/8" high lettering etched through the outer covering. White engraved letters on black background. Attach with plated self-tapping screws or brass bolts.
- D. Provide nameplates on all existing equipment that a circuit under this contract is fed from.
- E. All junction box covers shall be hand marked with a 1/8" wide permanent black marking pen, indicating panel and circuit numbers contained, or system contained, i.e., fire alarm, telephone, etc.

#### 1.7 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected, and architectural room elevations.

#### 1.8 ELECTRICAL INSTALLATIONS

- A. Coordinate electrical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.
- G. Coordinate connection of electrical systems with local utility services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connections for each service.

#### 1.9 CUTTING AND PATCHING

- A. This Article specifies the cutting and patching of electrical equipment, components, and materials to include removal and legal disposal of selected materials, components, and equipment.
- B. Do not endanger or damage installed Work through procedures and processes of cutting and patching.
- C. Arrange for repairs required to restore other work, because of damage caused as a result of electrical installations.
- D. No additional compensation will be authorized for cutting and patching Work that is necessitated by ill-timed, defective, or non-conforming installations.
- E. Perform cutting, fitting, and patching of electrical equipment and materials required to:
  1. Uncover Work to provide for installation of ill-timed work;
  2. Remove and replace defective Work;
  3. Remove and replace Work not conforming to requirements of the Contract Documents;
  4. Remove samples of installed Work as specified for testing;
  5. Upon written instructions from the Architect/Engineer, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.
  6. Install electrical work in existing facilities.

#### 1.10 ELECTRICAL SUBMITTALS

- A. Refer to the Conditions of the Contract (General and Supplementary) and Division-01 Section: SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES for submittal definitions, requirements, and procedures.

- B. Submittal of shop drawings, product data, and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Architect/Engineer will not be processed.

#### 1.11 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Refer to the Instructions to Bidders and the Division-01 for requirements in selecting products and requesting substitutions. Where a listing of acceptable manufacturers has been given, use one of those manufacturers given only.

#### 1.12 PRODUCT LISTING

- A. Prepare listing of major electrical equipment and materials for the project.
- B. Provide all information requested.
- C. Submit this listing as a part of the submittal requirement specified in Division-01.
- D. When two or more items of the same material or equipment are required they shall be of the same manufacturer, i.e., panelboards, motor starters, transformers, etc. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in Work, except as otherwise indicated.
- E. Provide products which are compatible within systems and other connected items.

#### 1.13 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- C. Coordinate deliveries of electrical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

#### 1.14 RECORD DOCUMENTS

- A. Refer to the Division-01 Section: PROJECT CLOSEOUT or PROJECT RECORD DOCUMENTS for requirements. The following paragraphs supplement the requirements of Division-01.
- B. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details.
- C. Mark Specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

#### 1.15 OPERATION AND MAINTENANCE DATA

- A. Refer to the Division-01 Section; PROJECT CLOSEOUT or OPERATION AND MAINTENANCE DATA for procedures and requirements for preparation and submittal of maintenance manuals.

#### 1.16 WARRANTIES

- A. Refer to individual equipment specifications for warranty requirements.
- B. Compile and assemble the warranties specified in Division-26, into a separate set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

- C. Provide complete warranty information for each item to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

1.17 CLEANING

- A. Refer to the Division-01 Section; PROJECT CLOSEOUT or FINAL CLEANING for general requirements for final cleaning.
- B. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

1.18 TEMPORARY POWER

- A. Provide and pay for all temporary electrical service as required for construction.
- B. Provide all temporary lighting and power distribution as required for construction. All temporary electrical work shall be in accordance with the N.E.C.

1.19 ELECTRONIC FILES

- A. CADD files will be available on a limited basis to qualified firms at the Architects prerogative. Recipients are cautioned that these files may not accurately show actual conditions as constructed. Users are responsible to verify actual field conditions. These files are not intended to be used as shop drawings.

END OF SECTION

**SECTION 26 05 19**

**LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 - GENERAL**

1.1 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.

1.2 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 CONDUCTORS AND CABLES

- 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:
  - 1. Alcan Products Corporation; Alcan Cable Division.
  - 2. American Insulated Wire Corp.; a Leviton Company.
  - 3. General Cable Corporation.
  - 4. Senator Wire & Cable Company.
  - 5. Southwire Company.
- B. Copper Conductors: Comply with NEMA WC 70.
- C. Aluminum Conductors: Comply with NEMA WC 70.
  - 1. Aluminum conductors shall be compact stranded aluminum alloy with XHHW-2 insulation. Alcan Stabiloy AA-8030 Series, 600 Volt. UL listed and labeled.
- D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN and XHHW.
- E. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

- 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:
  - 1. AFC Cable Systems, Inc.
  - 2. Hubbell Power Systems, Inc.
  - 3. O-Z/Gedney; EGS Electrical Group LLC.
  - 4. 3M; Electrical Products Division.
  - 5. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

**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. Panel board Feeders and Service Entrance: Copper for No. 1 AWG and smaller; aluminum for No. 1/0 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Use conductor not smaller than No. 12 AWG for power and lighting circuits.

### 3.2 ALUMINUM CONDUCTORS

- A. Aluminum conductors shall be used for panelboard feeders and service entrance conductors only.
- B. Connections:
  - 1. Wire from the load side of all disconnects switches to connect moving, vibrating, heat producing equipment (including indoor transformers), shall be copper. Proper UL accepted lugs must be provided in the disconnect switch for size and type of wire used. No aluminum shall be connected to motors.
- C. Terminations, Splices and Taps:
  - 1. Where aluminum conductors, No. 1 AWG and larger are terminated, spliced or tapped, the connectors shall be color-coded, tool applied compression type made of aluminum with wire barrels factory prefilled with oxide inhibiting compound.
  - 2. Connectors must pass UL Standard, bear markings AL7CU (75 degrees C) or AL97C (90 degrees C) for application, and have UL label.
  - 3. Set screw type connectors are not acceptable.
  - 4. Installation shall be as follows:
    - a. Installing tools and dies, of hexagonal or circumferential type made by the connector manufacturer shall be used for installation. Tooling shall be with color-coded or dieconnector coding system for inspection purposes. Where UL listing is applicable for connectors, the manufacturer's recommended toolings shall be used. Conductors shall be cleaned with a wire brush immediately before connecting.
    - b. Terminal lugs with bolting pads shall be tinplated for low contact resistance.
    - c. The connectors shall meet the performance requirement Underwriters Laboratories Test of UL, except that heating or current cycling tests shall be for a minimum of 500 cycles.
    - d. Belleville-type compression washers shall be used with all bolted connections properly tightened with a torque wrench.
    - e. Taps and/or splices made of dissimilar metals shall be made with accepted connectors of a type where they never come in direct contact with each other.

### 3.3 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Feeders: Type THHN-THWN, single conductors in raceway
- C. Branch Circuits: Type THHN-THWN, single conductors in raceway
- D. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- E. Class 2 Control Circuits: Type THHN-THWN, in raceway, unless specified otherwise.

### 3.4 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.

### 3.5 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 12 inches of slack.
- D. Interior Locations:
  - 1. All (non-electronic systems) copper taps and splices in No. 8 or smaller shall be fastened together by means of "spring type" connectors. All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire.
- E. Exterior Locations:
  - 1. Make splices, taps and terminations above grade in splice or termination cabinets. Do not splice any cable in ground or below finished grade.
  - 2. All taps and splices shall be made with compression type connectors and covered with Raychem heavywall cable sleeves (type CRSM-CT, WCSM or MCK) with type "S" sealant coating with sleeve kits as per manufacturer's installation instructions or be terminated/connected to terminal strips in above grade terminal boxes suitable for use.
  - 3. Provide and install above grade termination cabinets sized to meet applicable codes and standards, where required for splicing.
- F. Terminations, Splices and Taps:
  - 1. Where aluminum conductors, No. 1 AWG and larger are terminated, spliced or tapped, the connectors shall be color-coded, tool applied compression type made of aluminum with wire barrels factory prefilled with oxide inhibiting compound.

### 3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

### 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 and feeder conductors for compliance with requirements.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors o. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
    - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION



**SECTION 26 05 26**

**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. 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:
  - 1. Stranded Conductors: ASTM B 8.
  - 2. Tinned Conductors: ASTM B 33.
  - 3. Bonding Conductor: Stranded conductor, minimum size per NEC.
  - 4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL 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, 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.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 5/8 inch by 30 feet in length minimum.

**PART 3 - EXECUTION**

3.1 ERECTION TOLERANCES

- A. General:
  - 1. Install products in accordance with manufacturer's instructions.
  - 2. Provide grounding to meet (or exceed as required to meet these design criteria) all requirements of the NEC, the NFPA, and applicable standards of IEEE.
  - 3. Where there is a conflict between this design guideline and applicable codes/standards or other guideline, then the most stringent requirement is to govern.

4. Requirement in this design guideline to comply with a specific code/standard article, etc. is not to be construed as deleting of requirements of other applicable codes/standards and their articles, etc.

**B. Grounding Electrodes:**

1. All connections are to be by exothermic weld unless otherwise noted. All connections above grade and in accessible locations may be by exothermic welding or by braising or clamping with devices listed as suitable for use except in locations where exothermic welding is specified in these design criteria or called for by the engineer on the drawings.
2. Each rod is to be die stamped with identification of manufacturer and rod length.
3. Ground Resistance:
  - a. Main Electrical Service (to each building) and Generator Locations:
    - 1) Grounding resistance measured at each main service electrode system and at each generator electrode system is not to exceed 5 ohms.
  - b. Other Locations:
    - 1) Resistance to ground of all non-current carrying metal parts is not to exceed 5 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.
    - 2) Lightning Protection system ground locations are not to exceed 5 ohms for the Franklin system measured at ground electrode.
  - c. Resistance called for above is to be maximum resistance of each ground electrode prior to connection to grounding electrode conductor. Where ground electrode system being measured consists of two (2) or more ground rod electrodes then the resistance specified above is to be the maximum resistance with two (2) or more rods connected together but not connected to the grounding electrode conductor.
4. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor). Depending on soil conditions, etc. of ground rod locations it has been found that the ground rod lengths required to achieve the specified resistance may range from the minimum specified length to up to 80 feet or more in length.
5. Provide grounding well with cover at each rod location. Install grounding well top flush with finished grade.
6. Verify that final backfill and compaction has been completed before driving rod electrodes.
7. Install ground rods not less than 1 foot below grade level and not less than 2 feet from structure foundation.

**C. Grounding Electrode Conductor:**

1. Provide conductor sized to meet (or exceed as required to meet these design criteria) the requirements of NEC 250.

**D. Equipment Grounding Conductor:**

1. Provide grounding conductors with every circuit to meet (or exceed as required to meet these design criteria) the requirements of NEC 250.
2. At every voltage level, provide new portions of the electrical power distribution system grounded with a dedicated copper conductor, which extends from termination back to power source in supply panelboard.
3. Provide separate, insulated (bare if with feeder in PVC conduit outside of building(s)) conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
4. Except as otherwise indicated, each feeder raceway on the load side of the service entrance shall contain a ground conductor sized as indicated and where not shown shall be sized to meet (or exceed as required to meet these design criteria) the requirements of NEC 250. Ground conductor shall be connected to the equipment grounding bus in switchboards and panelboards, to the Grounding Bus in all motor control centers, and as specified, to lighting fixtures, motors and other types of equipment and outlets. Provide a ground in addition to the metallic raceway, properly connected thereto, using a lug device located within each item enclosure at the point of electric power connections to permit convenient inspection.
5. Provide a green insulated ground wire for all grounding type receptacles and for equipment of all voltages, In addition to grounding strap connection to metallic outlet boxes, provide a supplemental grounding wire and screw equal to Raco No. 983 and connect receptacle ground terminal to the box.

6. Provide plugstrips and metallic surface raceway containing a green insulation ground conductor from supply panel ground bus connected to grounding screw on each receptacle in strip and to strip channel. Conductor shall be continuous.
7. Where integral grounding conductor is specified elsewhere in bus duct construction, provide equivalent capacity conductor from supply switchboard or panelboard grounding bus to the bus duct grounding conductor. Bond integral conductor to bus duct enclosure at each tap and each termination.
8. At all motors, all heating coil assemblies, and all building equipment requiring flexible connection, provide a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with accepted connectors regardless of conduit size or type. This is to include Food Service equipment, Laundry equipment, and all other "Equipment by Owner" to which an electric conduit is provided under this Division.

E. Main Electrical Service:

1. Existing Buildings:
  - a. Contractor shall verify that each building's electrical service is properly grounded as required by the NEC.
  - b. Provide electrical service grounding at each building as called for herein for all existing services that do not comply with the grounding described above.
  - c. Supplement existing electrical service grounding at each building as required to comply with all requirements in these criteria.
  - d. If exterior ground rod electrode does not exist at each building's main electrical service, provide ground rods as called for main electrical service, exterior of building. Connect all counterpoise conductors required elsewhere thereto.
2. Complete installation is to meet and exceed the requirements of the NEC 250.
3. Provide additional electrodes for the main service in sufficient number and configuration to secure resistance specified.
4. Bond to all of the following when available on site:
  - a. Ground Rods
  - b. Metal Water Pipe (Interior and Exterior to Building)
  - c. Building Metal Frame, Structural Steel and/or Reinforced Structural Concrete
  - d. All Piping Entering or Leaving All Buildings (Excluding Chilled Water Piping and gas lines)
  - e. Encasing Electrodes
  - f. Ground Ring
  - g. Site Distribution Counterpoise Ground System
  - h. Lightning Protection System
5. Provide a main ground, bare copper conductor, sized per applicable table in NEC 250, but in no case less than #2/0, run in conduit from the main switchgear of each building to the building steel in respective building. Provide ground conductor run individually from the main switchgear and bonded to the main water service ahead of any union in pipe and must be metal pipe of length as acceptable by authorities having jurisdiction. Provide properly sized bonding shunt around water meter and/or dielectric unions in the water pipe. Also required is the same size ground wire to ground rod electrode as called for below:
  - a. Two (2) - 20 ft. ground rods in a horizontal configuration at no less than 30 ft. spacing driven to a minimum depth of 20 ft. plus 1 ft. below grade.
  - b. Bond ground rod electrodes together with a bare copper ground conductor that matches size required by applicable table in NEC 250, but in no case less than #2/0.
  - c. Provide additional rod electrodes as required to achieve specified ground resistance.
6. Ground/bond neutral as per NEC 250.
7. Bond grounding electrodes to site counterpoise grounding system and lightning protection system where provided.
8. Provide ground bus bar on wall near main service disconnect/switchboard. Connect to ground bar in disconnect/switchboard bonded to switchboard/disconnect enclosure/neutral with copper grounding conductor sized per applicable table in NEC 250.

F. Transformer Grounding:

1. Ground all transformers and enclosures of 120/208V and 277/480V "separately derived systems" as specified herein.
  - a. Ground per NEC 250 and these criteria.
  - b. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per applicable table in NEC 250.

**ADDENDUM NO. 2  
ATTACHMENT F**

- c. Connect transformer neutral/ground to grounding electrode per NEC 250 with grounding electrode conductor sized per applicable table in NEC 250.
  - d. In addition to connection to grounding electrode conductor called for above (i.e. per NEC 250) provide, install and connect supplemental grounding electrode as follows:
    - 1) Where grounding required per NEC 250 is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
    - 2) Where grounding connection required per NEC 250 is to grounded metal water pipe, supplement this grounding with connection to other electrodes specified in NEC 250.
    - 3) Where supplemental grounding electrodes are required, provide, install and connect two or more 30 ft ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade.
  - e. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade.
  - f. Where transformer is mounted exterior to building one (1) of the two (2) ground electrodes required is to be ground rod electrode as called for in 5 above. This ground rod electrode is also to be connected to counterpoise system. (wherever counterpoise system is available).
  - g. Ground to water system service pipe as required by NEC 250.
- 2. Provide additional ground electrodes as required to achieve specified ground resistance.
  - 3. Where two or more ground electrodes are used at any one required ground location, they are to be bonded together with a copper ground conductor, sized to meet applicable table in NEC 250, but in no case less than #2/0.
  - 4. Provide equipment ground conductors in addition to above grounding. See "Equipment Grounding Conductor".
  - 5. Provide ground bus bar on wall near transformer (or in associated electrical room for exterior mounted transformers). Connect to ground lug in transformer bonded to transformer enclosure/neutral with copper ground conductor sized per applicable table in NEC 250.
- G. Generator Grounding:
- 1. Separately derived systems (i.e. systems where generator neutral is not solidly interconnected to service supplied system neutral such as 4-pole switched neutral transfer switch systems).
    - a. Ground per NEC 250 and these criteria.
    - b. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per applicable table in NEC 250.
    - c. Connect generator neutral/ground to grounding electrodes per NEC 250 with grounding electrode conductor sized per applicable table in NEC 250.
    - d. In addition to connection to grounding electrode conductor called for above (i.e. per NEC 250) provide and connect supplemental grounding electrode as follows:
      - 1) Where grounding required per NEC 250 is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
      - 2) Where grounding connection required per NEC 250 is a grounded metal water pipe, supplement this grounding with connection to other electrodes specified in NEC 250.
      - 3) Where supplemental grounding electrodes required above is a ground rod electrode, provide and connect two or more 30 ft. ground rod electrodes at no less than 30 ft spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade.
    - e. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade.
    - f. Where generator is mounted exterior to building one (1) or the two (2) ground electrodes required are to be ground rod electrode as called for in 5 above. This ground rod electrode is to also be connected to counterpoise system.
  - 2. Non-separately derived systems (i.e. systems where generator neutral is solidly interconnected to service supplied system neutral such as 3-pole non-switched neutral transfer switch systems).
    - a. Ground per NEC 250 and these criteria.
    - b. Do not bond neutral to transformer frame/enclosure or the equipment grounding conductors of the derived system.

- c. Connect generator frame/enclosures ground to grounding electrode per NEC 250 with grounding electrode conductor sized per applicable table in NEC 250.
  - d. In addition to connection to grounding electrode conductor called for above (i.e. per NEC 250) provide and connect supplemental grounding electrode as follows:
    - 1) Where grounding required per NEC 250 is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
    - 2) Where grounding connection required per NEC 250 is to be grounded metal water pipe, supplement this grounding with connection to other electrodes specified in NEC 250.
    - 3) Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade.
  - e. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 ft. below grade.
  - f. Where generator is mounted exterior to building one (1) of the two (2) ground electrodes required is to be ground rod electrode as called for in 5 above. This ground rod electrode is to also be connected to the counterpoise system.
3. Provide additional ground electrodes as required to achieve specified ground resistance.
  4. Where two or more ground electrodes are used at any one required ground location, they are to be bonded together with a copper ground conductor, sized to meet applicable table in NEC 250, but in no case less than #2/0.
  5. Complete installation is to exceed the minimum requirements of NEC 250.
  6. Provide equipment ground conductors in addition to above grounding. See "Equipment Grounding Conductor".
- H. Lightning Protection System:
1. Ground per applicable section on lightning protection system NFPA 780, and as specified herein. The most stringent requirements are to govern.
  2. Bond lightning protection system grounds to electrical service system ground, all piping entering or leaving all buildings (except gas and HVAC piping), and counterpoise system ground where provided.
  3. See Design Criteria DG 26 41 13.
- I. Exterior Grade (or free standing above ground) Mounted Equipment:
1. General:
    - a. All equipment (including chillers, pumps, disconnects, starters, control panels, panels, etc.) mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.
    - b. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by applicable table in NEC 250 based on equipment feeder size, but in no case is the conductor to be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.
  2. Main electrical service rack mounted equipment.
    - a. Ground per "Main Electrical Service"
    - b. Bond all metal parts as noted above.
  3. Electrical sub service rack mounted equipment.
    - a. Ground per "Main Electrical Service", except do not bond neutral to ground.
    - b. Bond all metal parts as noted above.
  4. Electrical equipment connection rack mounted equipment.
    - a. Bond all metal parts as noted above.
  5. Grounding electrodes (ground electrodes system) is to be:
    - a. Located at each rack location.
    - b. For service equipment: Ground electrode required per "Main Electrical Service".
    - c. For equipment connection equipment: Two or more 30 ft. ground rods at no less than 30 ft. spacing, driven vertical to a minimum depth of 1 ft. below grade. Bond the two or more ground rods together with a size to meet applicable table in NEC 250, but no less than #2 copper

ground conductor. Provide additional rod electrodes as required to achieve specified ground resistance.

6. Complete installation is to exceed the minimum requirements of NEC 250 and, when applicable, NFPA 780.

J. Roof Mounted Equipment:

1. Bond all roof mounted electrical equipment to lightning protection system (when provided) per NFPA 780.

K. Lighting Fixtures:

1. All new and removed/reinstalled fixtures in building interior, and exterior fixtures are to be provided with green grounding conductor, solidly connected to unit. Provide individual fixture grounds with lug to fixture body, generally located at point of electrical connection to the fixture unit.
2. All suspended fixtures and those supplied through flexible metallic conduit shall have green ground conductor from outlet box to fixture. Cord connected fixtures are to contain a separate green ground conductor.

3. Pole Light Fixtures:

a. Metal Pole Light Fixtures:

- 1) Freestanding pole mounted lighting fixtures are to each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.
- 2) Conductor shall be bonded to metal pole via UL Listed ground clamp suitable for use. Locate ground lug opposite to handhole (or adjacent if visible through handhole).

b. Concrete or Non-Metallic Pole:

- 1) Freestanding pole mounted lighting fixtures are to each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.
- 2) Conductor shall be extended from grounding electrode to top of pole and terminated at the top of pole in a Class I or Class II copper lightning protection air terminal.
- 3) Each metal part of light fixture assembly, bracket, ballast cabinet, disconnect, transformer, etc. that is mounted to pole is to be bonded to down conductor.

c. Fixtures located on elevated roadway ramps shall be specially provided with a connection to lightning counterpoise grounding system, properly installed.

d. Grounding electrode(s) at each pole are to be connected (bonded) to site distribution counterpoise system.

e. Grounding Electrodes:

- 1) Two or more 10 ft. ground rods at no less than 10 ft. spacing are to be driven vertically to a minimum depth of 10 ft. plus 1 ft. below grade.
- 2) Bond two or more ground rod electrodes together with a Class I or Class II lightning protection main copper conductor.
- 3) Provide additional rod electrodes as required to achieve specified ground resistance.
- 4) The two (2) or more grounding rod electrodes are to be installed at each light pole.

f. Installation is to exceed minimum requirements of NFPA 780.

L. Pullbox, Manhole, Handhole Grounding:

1. One 30 ft. ground rod electrode is to be driven vertically to a minimum depth of 30 ft. plus 1 ft. below grade in each manhole, handhole or pullbox (in ground).
2. The complete installation is to exceed the minimum requirements of the NEC.
3. Provide additional ground rod electrodes as required to provide resistance called for herein.
4. Where more than one ground rod electrode is required bond the two or more ground rod electrodes together with a copper ground conductor.
5. Bond to counterpoise system (whenever counterpoise system is provided).
6. Bond grounding electrode to all exposed metal parts of manhole, handhole, and pullbox (including metal cover) with #6 copper ground conductor. Connect to ground rod electrode with exothermic weld. Connect to metal cover with exothermic weld. Connect to other metal parts with exothermic weld or listed grounding clamp. Provide 3 ft. or more slack ground cable on cover connections required to facilitate removal of cover.

- M. Hazardous Locations:
1. Ground in hazardous locations is to be done in accordance with applicable portions of the National Electrical Code.
- N. Ground Ring:
1. Provide complete underground building perimeter ground ring system, completely encircling each building.
  2. Conductor is to be minimum of Class II lightning protection copper conductor (bare).
  3. Install at not less than 2-1/2 feet depth into earth.
  4. Install ground rods (minimum 30 ft. long) every 150 feet section of ground ring conductor.
  5. Bond ground ring to building steel every 150 feet of building perimeter, bond to any and all electrical and piping systems that cross the ground ring system, bond to lightning protection down conductors and to any lightning or other earth grounding electrodes that may be present on the premises.
  6. Bond to building service and counterpoise ground systems.
- O. Miscellaneous Grounding Connections:
1. Provide bonding to meet regulatory requirements.
  2. Required connections to building steel are to be with listed non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where weld will affect the structural properties of the steel. Required connections to existing building structural steel purlins/I-beams are to be with heavy duty bronze "C" clamp with two bolt vice-grip cable clamp.
  3. Grounding conductors shall be installed as to permit shortest and most direct path from equipment to ground; be installed in conduit; be bonded to conduit at both ends when conduit is metal; have connections accessible for inspection; and made with accepted solderless connectors brazed (or bolted) to the equipment or to be bare copper; be run in conduit with power and branch circuit conductors. The main grounding electrode conductor is to be exothermically welded to ground rods, water pipe, and building steel.
  4. All surfaces to which grounding connections are made are to be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing is to be removed at grounding contact surfaces, for 0 ohms by digital Vm. Exposed bare metal at the termination point is to be painted.
  5. All ground connections that are buried or in otherwise inaccessible locations are to be welded exothermically. The weld is to provide a connection which will not corrode or loosen and which is to be equal or larger in size than the conductors joined together. The connection is to have the same current carrying capacity as the largest conductor.
  6. Provide ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up from underground non-metal conduit, into a motor control center enclosure or at ground bus bar mounted on the wall). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.
  7. Provide ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.
  8. Each feeder metallic conduit is to be bonded at all discontinuities, including at switchboards and all sub-distribution and branch circuit panels with conductors in accordance with applicable table in NEC 250 for parallel return with respective interior grounding conductor.
  9. Grounding provisions shall include double locknuts on all heavy wall conduits.
  10. Bond all metal parts of pole light fixtures to ground rod at base.
  11. Provide grounding bus in all existing panelboards of remodeled areas, for connection of
  12. Bond together reinforcing steel and metal accessories in pool and fountain structures.
  13. Where a reinforced concrete pad is utilized in the grounding system, secure low resistance to earth of the pad with "thermite" type devices, and/or #10AWG wire ties to tie together the pad reinforcing steel. No less than ten (10) full length rebars shall be so connected (by Division 26 contractor) and used as a grounding electrode in the grounding system.
- P. Grounding Bar:
1. Indicate on the drawings where to provide grounding bar. These installations are intended to provide a low-impedance "earthing" path for surge voltages, which are electrically "clamped" and shunted to earth by variable-impedance surge protective devices. Metal sheaths of underground cables are also to be grounded thereto at points of building entrance.
  2. Mount lugs with appropriately sized hex head bolts to bus bar at 2" on center spacing, one for each ground conductor.

3. Mount bus bar to wall using 2" polyester molded insulator stand-off.
4. Extend a #2/0 (minimum size) or larger (if larger size is required by the NEC) THWN insulated copper ground conductor in PVC conduit to accepted service ground installation or ground bus/bar in main service equipment enclosure.
5. Extend a #6 insulated copper ground wire from respective bus/bar to each "local" ground bus/bar in each cabinet for Division 27 00 00 system.
6. "SYSTEMS" grounding bus/bar must be compliant with requirements of NEC 800.

Q. Counterpoise System:

1. Counterpoise shall run to building and grounded at each building to the main building service ground rod electrode (exterior to building). Provide ground rod at all light poles, pullboxes, manholes, handholes and at each building. Provide appropriate ground every 150 ft. length of counterpoise conductor (see "Grounding Electrodes").

R. Communications Systems:

1. Provide grounding as required by NEC and where applicable on the project: Articles (Radio and Television Equipment); (Community Antenna Television and Radio Distribution Systems; and (Network-Powered Broadband Communications Systems).
2. Provide grounding electrode at point of entry of communications cables and bond to service entrance grounding electrodes per NEC 800. Provide ground bus bar at point of entry of communications cable and connect electrode to ground bus. Connect communications cable metal sheath and surge protection devices to ground bar.

S. Tests and Reports:

1. Raceway continuity: Metallic raceway systems as a component of the facility ground system are to be tested for electrical continuity. Resistance to ground throughout the system is not to exceed specified limits.
2. Ground resistance measurements shall be made on each system utilizing the project. The ground resistance measurements shall include building structural steel, driven grounding system, water pipe grounding system and other accepted systems as may be applicable. Ground resistance measurements are to be made in normally dry weather, not less than 24 hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured are not to exceed specified limits.
3. Upon completion of testing, the test conditions and results are to be certified by the Contractor and submitted to the Architect/Engineer.

### 3.2 FIELD QUALITY CONTROL

A. 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, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
  - a. Measure ground resistance no fewer 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.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. Report measured ground resistances that exceeds 5 ohms.

END OF SECTION



**SECTION 26 05 29**

**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.3 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.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

**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. 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:
    - 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.

g. Wesanco, Inc.

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. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless 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. 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:

- 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.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.

6. Hanger Rods: Threaded steel.

## 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.

## **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 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 single-bolt conduit clamps using spring friction action for retention in support channel.

- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch 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.
- 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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, spring-tension clamps.
  - 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.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. 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 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 28-day compressive-strength 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.

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

END OF SECTION

**SECTION 26 05 33**

**RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Metal conduits, tubing, and fittings.
  - 2. Nonmetal conduits, tubing, and fittings.
  - 3. Surface raceways.
  - 4. Boxes, enclosures, and cabinets.
  - 5. Handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

- A. EMT: Electrical Metallic Tubing.
- B. ENT: Electrical Nonmetallic Tubing.
- C. FMC: Flexible Metal Conduit.
- D. GRC: Galvanized Rigid (steel) Conduit.
- E. IMC: Intermediate Metal Conduit.
- F. LFMC: Liquidtight Flexible Metal Conduit.
- G. RNC: Rigid Nonmetallic Conduit.

1.3 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 CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Allied Tube & Conduit; a Tyco International Ltd. Co.
  - 3. Anamet Electrical, Inc.
  - 4. Electri-Flex Company.
  - 5. O-Z/Gedney; a brand of EGS Electrical Group.
  - 6. Southwire Company.
  - 7. Thomas & Betts Corporation.
  - 8. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.

- E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch, minimum.
- F. EMT: Comply with ANSI C80.3 and UL 797.
- G. FMC: Comply with UL 1; zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Set-screw or compression.
  - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
  - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
  - 4. All metallic fittings shall be furnished with zinc-coating, or other approved application.
- J. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Anamet Electrical, Inc.
  - 3. Arnco Corporation.
  - 4. CANTEX Inc.
  - 5. Carlon Corp.
  - 6. Condux International, Inc.
  - 7. Electri-Flex Company.
  - 8. Lamson & Sessions; Carlon Electrical Products.
  - 9. RACO; a Hubbell company.
  - 10. Thomas & Betts Corporation.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. LFNC: Comply with UL 1660.
- F. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- G. Fittings for LFNC: Comply with UL 514B.

## 2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cooper Technologies Company; Cooper Crouse-Hinds.
  - 2. Hoffman; a Pentair company.
  - 3. Hubbell Incorporated; Killark Division.
  - 4. O-Z/Gedney; a brand of EGS Electrical Group.
  - 5. RACO; a Hubbell Company.

6. Robroy Industries.
  7. Thomas & Betts Corporation.
  8. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations. Stamped steel boxes shall not be used in exposed areas. Bell boxes are not permitted. Four inch square boxes are to be one piece/stamped/drawn boxes, welded boxes are not permitted.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
1. Material: Cast metal or sheet metal.
  2. Type: Fully adjustable.
  3. Shape: Rectangular.
  4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  5. Basis of Design: Wiremold/Legrand RFB4 or equal.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- I. Hinged-Cover Enclosures: Comply with UL 50 and 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.
- J. 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.

#### 2.4 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
  2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Quazite.
    - b. Armorcast Products Company.
    - c. Carson Industries LLC.
    - d. CDR Systems Corporation; Hubbell Power Systems.
    - e. NewBasis.
    - f. Oldcastle Precast, Inc.; Christy Concrete Products.
  2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
  3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  4. Cover Legend: Molded lettering, "ELECTRIC."

**PART 3 - EXECUTION**

**3.1 RACEWAY APPLICATION**

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC, IMC.
  2. Concealed Conduit, Aboveground: Rigid steel conduit, GRC, IMC.
  3. Underground Conduit: RNC, Type EPC-40-PVC.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
  6. 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 or Fiberglass-reinforced polyester resin, 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 vertical loading.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage, which is interpreted to be above 90" above ground: EMT.
  2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Raceway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
  3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  5. Damp or Wet Locations: Rigid steel conduit
  6. Raceways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
  7. Raceways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: EMT.
  8. Raceways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber/communications-cable raceway or EMT.
  9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Minimum Raceway Size for Switch legs: 1/2-inch trade size.
- E. 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. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

**3.2 INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter.
- B. Keep raceways at least 6 inches 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. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support conduit within 12 inches of enclosures to which attached.
- H. Raceways Embedded in Slabs:
  - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
  - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
  - 3. Change from ENT to GRC before rising above floor. Conduit shall be GRC for a minimum of 6" above penetration.
  - 4. Protect conduit from corrosion at penetration through slab with PVC coating, bituminous mastic, or taping (2 inch wide minimum Scotchwrap No. 50 with 50% overlay.)
- I. Stub-ups to Above Recessed Ceilings:
  - 1. Use EMT, IMC, or RMC for raceways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- N. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- O. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
  - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
  - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
  - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway 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.
- P. Install raceway sealing fittings at accessible locations according to NFPA 70 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 according to NFPA 70.
- Q. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.

- R. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- S. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation.
- T. Flexible Conduit Connections: Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations.
- U. 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.
- V. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- W. Set metal floor boxes level and flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit.
  - 2. Install backfill.
  - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
  - 4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
  - 5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
    - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
  - 6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
  - 7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- E. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

### 3.6 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

**SECTION 26 05 44**

**SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  2. Sleeve-seal systems.
  3. Sleeve-seal fittings.
  4. Grout.
  5. Silicone sealants.

**PART 2 - PRODUCTS**

2.1 SLEEVES

- A. Wall Sleeves:
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
  2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
1. Material: Galvanized sheet steel.
  2. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
    - b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

- 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, 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 Company (The).
    - d. Pipeline Seal and Insulator, Inc.
    - e. Proco Products, Inc.
  2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  3. Pressure Plates: Carbon steel.
  4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.5 FIRE RATED RACEWAY AND CABLE PENETRATION

- A. System used for penetrations shall be NRTL listed as suitable for the purpose and shall maintain the original fire rating of the penetrated floor, wall, etc.

**PART 3 - EXECUTION**

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work. Roof penetrations shall be avoided if at all possible.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install 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.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

**SECTION 26 05 53**

**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Underground-line warning tape.
  - 5. Warning labels and signs.
  - 6. Instruction signs.
  - 7. Equipment identification labels.
  - 8. Miscellaneous identification products.

1.2 QUALITY ASSURANCE

- A. Comply with ANSI A13.1
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.3 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

**PART 2 - PRODUCTS**

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field
  - 2. Legend: Indicate voltage.
- C. Painted Junction Boxes Couplings for Raceways Carrying Circuits at 600 V or Less: All conduit system junction boxes (except those subject to view in public areas) are to be color coded as listed:

COLOR CODE FOR JUNCTION BOXES WITH KRYLON PAINT NUMBER

System Emergency 277/480 volt	Cherry Red	K2101
System Emergency 120/208 volt	Zinger Pink	S1150
Fire Alarm	Safety Orange	2410
Normal Power 277/480 volt	Leather Brown	K2501
Normal Power 120/208 volt	Glossy Black	K1601
Fiber Optics	Safety Purple	1929
Sound System	Safety Yellow	1813
Intercom	True Blue	K1910
Computer/Data	Bright Gold	K1701
TV	Glossy White	K1501
BAS	Antique White	K1503
Security/CCTV	John Deere Green	K1817
Telephone	Safety Green	2012
Grounding	Green	3106

- D. Painted Color Bands for Raceways Carrying Circuits at 600 V or Less: Conduits longer than 20 feet are to be painted with the above listed color paint bands 20 feet on center. Paint band is to be 4" in length, applied around entire conduit. Where conduits are parallel on conduit racking, paint bands are to be evenly aligned. Paint is to be neatly applied and uniform. Paint boxes and raceways prior to installation or tape conduits and surrounding surfaces to avoid overspray. Paint overspray is to be removed.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Colors for Raceways Carrying Circuits at 600 V and Less:
1. Black letters on an orange field.
  2. Legend: Indicate voltage.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- C. Single Conductor Control Wires: Identify with pre-printed sleeve type heat-shrink marker, with wire number, at each termination.

2.5 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
  2. Printing on tape shall be permanent and shall not be damaged by burial operations.



3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
  2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
  3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

## 2.6 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  2. 1/4-inch grommets in corners for mounting.
  3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
  2. 1/4-inch grommets in corners for mounting.
  3. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following example legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

## 2.7 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with black letters on white face
  2. Punched or drilled for mechanical fasteners.
  3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

## 2.8 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic, or Melamine Label: Punched or drilled for screw mounting. White letters on a dark gray background. Minimum letter height shall be 3/8 inch.

## 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Panelboard engraved labels shall be mechanically fastened using rivets or screws.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

**3.2 IDENTIFICATION SCHEDULE**

- A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.
- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Emergency Power.
  - 2. Power.
  - 3. UPS.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
    - c. Colors for 480/277-V Circuits:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
    - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
  - 1. Limit use of underground-line warning tape to direct-buried cables.
  - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
  - 1. Comply with 29 CFR 1910.145.
  - 2. Identify system voltage with black letters on an orange background.
  - 3. Apply to exterior of door, cover, or other access.
  - 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
- J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
  - 1. Labeling Instructions:
    - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high. Follow the Gulfstream panelboard labeling scheme.
    - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
  - 2. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Switchboards.

- e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
- f. Emergency system boxes and enclosures.
- g. Enclosed switches.
- h. Enclosed circuit breakers.
- i. Enclosed controllers.
- j. Variable-speed controllers.
- k. Power transfer equipment.
- l. Power-generating units.
- m. Monitoring and control equipment.

END OF SECTION

**SECTION 26 09 23**

**LIGHTING CONTROL DEVICES**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. This Section includes the following lighting control devices:
  - 1. Outdoor Photoelectric Switches.
  - 2. Indoor occupancy sensors.
  - 3. Lighting contactors.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.3 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.

**PART 2 - PRODUCTS**

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Cooper Industries, Inc.
  - 2. Intermatic, Inc.
  - 3. NSi Industries LLC; TORK Products.
  - 4. Tyco Electronics; ALR Brand.
- B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
  - 3. Time Delay: Fifteen second minimum, to prevent false operation.
  - 4. Surge Protection: Metal-oxide varistor.
  - 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Hubbell Lighting.
  - 2. Leviton Mfg. Company Inc.
  - 3. Lithonia Lighting; Acuity Lighting Group, Inc.
  - 4. Sensor Switch, Inc.
  - 5. TORK.
  - 6. Watt Stopper (The).
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
  - 1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
  - a. Sensor: Suitable for mounting in any position on a standard outlet box.
  - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
  - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

- C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.

## 2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Division 26 Section "Conductors and Cables."

## 2.4 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
  2. GE Industrial Systems; Total Lighting Control.
  3. MicroLite Lighting Control Systems.
  4. Square D; Schneider Electric.
  5. Watt Stopper (The).
- B. Description: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  3. Enclosure: Comply with NEMA 250.
  4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

**PART 3 - EXECUTION**

3.1 SENSOR INSTALLATION

- A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Conductors and Cables." Minimum conduit size shall be 1/2 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
  - 2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
- B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION

**SECTION 26 27 26**

**WIRING DEVICES**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
  - 2. Twist-locking receptacles.
  - 3. Weather-resistant receptacles.
  - 4. Snap switches and wall-box dimmers.
  - 5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranded building wire.
  - 2. Devices shall comply with the requirements in this Section.



### 2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 5351 (single), CR5362 (duplex).
    - b. Hubbell; HBL5351 (single), HBL5352 (duplex).
    - c. Leviton; 5891 (single), 5352 (duplex).
    - d. Pass & Seymour; 5361 (single), 5362 (duplex).

### 2.4 GFCI RECEPTACLES

- A. General Description:
  - 1. Straight blade, non-feed-through type.
  - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
  - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; GF20.
    - b. Hubbell; GFR5352L.
    - c. Pass & Seymour; 2084.
    - d. Leviton; 7590.

### 2.5 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; CWL520R.
    - b. Hubbell; HBL2310.
    - c. Leviton; 2310.
    - d. Pass & Seymour; L520-R.
    - e. Hubbell; IG2310.
    - f. Leviton; 2310-IG.

### 2.6 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
  - 1. Matching, locking-type plug and receptacle body connector.
  - 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
  - 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.
  - 4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

### 2.7 SNAP SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
    - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
    - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
    - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.8 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
- C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
  - 1. 600 W; dimmers shall require no derating when ganged with other devices.
- D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.9 OCCUPANCY SENSORS

- A. Wall-Switch Sensors:
  - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Cooper; 6111 for 120 V, 6117 for 277 V.
    - b. Hubbell; WS1277.
    - c. Leviton; ODS 10-ID.
    - d. Pass & Seymour; WS3000.
    - e. Watt Stopper (The); WS-200.
  - 2. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft..

2.10 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: 0.035-inch-thick, satin-finished, Type 302 stainless steel.
  - 3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
  - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

2.11 OUTDOOR/WET LOCATION

- A. Wet-Location, Weatherproof-in-Use Locations: Comply with requirements for listed wet-location while in-use assembly. Taymac or equivalent. Receptacles in such location shall be GFCI.

2.12 FLOOR SERVICE FITTINGS

- A. Type: Modular, flush-type, dual-service units suitable for wiring method used.
- B. Compartments: Barrier separates power from voice and data communication cabling.
- C. Service Plate: Rectangular, solid brass with satin finish.
- D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable.

2.13 FINISHES

- A. Device Color:
  - 1. Wiring devices and receptacles connected to normal power and located in finished spaces shall be ivory in color.
  - 2. Wiring devices connected to normal power and located in unfinished spaces shall be grey color. Receptacle devices for computer power shall be black color.

3. Wiring Devices Connected to Emergency Power System: Red.
4. Contractor shall modify any given catalog numbers as required to procure devices and plates of the proper color / material.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
  4. Existing Conductors:
    - a. Cut back or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
- D. Device Installation:
  1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  4. Connect devices to branch circuits.
  5. When there is a choice, use side wiring with binding-head screw terminals. Wrap conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw and tighten the screw clamp.
  6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
  7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  8. Tighten unused terminal screws on the device.
  9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
  1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
  1. Install dimmers within terms of their listing.
  2. Verify that dimmers used for fan speed control are listed for that application.
  3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates with switch position to be up when ON and down with OFF.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Tests for Convenience Receptacles:
  1. Line Voltage: Acceptable range is 105 to 132 V.
  2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  3. Ground Impedance: Values of up to 2 ohms are acceptable.
  4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  5. Using the test plug, verify that the device and its outlet box are securely mounted.
  6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- B. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION

**SECTION 26 28 13**

**FUSES**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Cartridge fuses rated 600-V ac and less for use in enclosed switches.

1.2 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

1.3 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.4 COORDINATION

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussmann, Inc.
  - 2. Ferraz Shawmut, Inc.
  - 3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

1. Motor Branch Circuits: Class RK5, time delay.
2. Other Branch Circuits: Class RK5, time delay.
3. Control Circuits: Class CC, time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

**SECTION 26 28 16**

**ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Horsepower ratings (as appropriate).

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

1.6 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances per NEC and for equipment access doors and panels.

**PART 2 - PRODUCTS**

2.1 FUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide:
  - 1. Square D; a brand of Schneider Electric.
  - 2. Eaton Electrical Inc.; Cutler-Hammer.
  - 3. General Electric Company; GE.

4. Siemens Energy & Automation, Inc.
- B. Type GD, General Duty, Single Throw, 240-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with cartridge fuse interiors to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
  1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Class R Fuse Kit: Provide rejection of other fuse types. Provide switch with Class R fuses.
  4. Lugs: Mechanical type, suitable for number, size, and conductor material.
  5. Internal Barrier Kit: Provides additional barrier that helps prevent accidental contact with live parts.
  6. Cover Viewing Window: Provides window over the blades to allow visual verification of ON-OFF status.

## 2.2 NONFUSIBLE SWITCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide:
  1. Square D; a brand of Schneider Electric.
  2. Eaton Electrical Inc.; Cutler-Hammer.
  3. General Electric Company; GE.
  4. Siemens Energy & Automation, Inc.
- B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
  1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Lugs: Mechanical type, suitable for number, size, and conductor material.
  4. Internal Barrier Kit: Provides additional barrier that helps prevent accidental contact with live parts.
  5. Cover Viewing Window: Provides window over the blades to allow visual verification of ON-OFF status.

## 2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1
  2. Outdoor Locations: NEMA 250, Type 3R.
  3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
  4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.



**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Furnish and install where required by code; by equipment manufacturer requirements; by Authority Having Jurisdiction.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
- B. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION

**SECTION 26 43 13**

**SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Ten years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
  - 1. Advanced Protection Technologies Inc. (APT).
  - 2. Eaton Corporation.
  - 3. Emerson Electric Co.
  - 4. GE Zenith Controls.
  - 5. LEA International; Protection Technology Group.
  - 6. Leviton Manufacturing Co., Inc.

7. PowerLogics, Inc.
  - C. SPDs: Comply with UL 1449, Type 2.
    1. SPDs with the following features and accessories:
      - a. Integral disconnect switch.
      - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
      - c. Indicator light display for protection status.
  - D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
  - E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
    1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    2. Line to Ground: 1200 V for 480Y/277 V and 1200 V for 208Y/120 V.
    3. Line to Line: 2000 V for 480Y/277 V and 1000 V for 208Y/120 V.
  - F. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:
    1. Line to Neutral: 700 V.
    2. Line to Ground: 1000 V.
    3. Line to Line: 1000 V.
  - G. SCCR: Equal or exceed 200 kA.
  - H. Inominal Rating: 20 kA.
- 2.3 PANEL SUPPRESSORS
- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:
    1. Advanced Protection Technologies Inc. (APT).
    2. Eaton Corporation.
    3. Emerson Electric Co.
    4. GE Zenith Controls.
    5. LEA International; Protection Technology Group.
    6. Leviton Manufacturing Co., Inc.
    7. PowerLogics, Inc.
  - C. SPDs: Comply with UL 1449, Type 2.
    1. Include LED indicator lights for power and protection status.
    2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
  - E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
    1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    2. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    3. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.
    4. Line to Line: 2000 V for 480Y/277 V and 1200 V for 208Y/120 V.
  - F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
    1. Line to Neutral: 700 V.
    2. Line to Ground: 700 V.

3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

- G. SCCR: Equal or exceed 200 kA.
- H. Inominal Rating: 20 kA.

## 2.4 ENCLOSURES

- A. Indoor Enclosures: NEMA 250, Type 1.
- B. Outdoor Enclosures: NEMA 250, Type 4X.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

### 3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
1. Compare equipment nameplate data for compliance with Drawings and Specifications.
  2. Inspect anchorage, alignment, grounding, and clearances.
  3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

**SECTION 26 51 00**

**INTERIOR LIGHTING**

**PART 1 - GENERAL**

1.1 SUMMARY

- A. Section Includes:
  - 1. Interior lighting fixtures, lamps, ballasts, LEDs, and drivers.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Lighting fixture supports.

1.2 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of lighting fixture including dimensions.
  - 2. Ballast, including BF.
  - 3. Energy-efficiency data.
  - 4. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
- B. Installation instructions.
- C. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
  - 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.
- D. Energy Efficiency: Meet applicable requirements of the IECC/DOE Energy Code and ANSI/ASHRAE/IESNA 90.1-2010 Energy Standard.

1.5 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.
- C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- D. Metal Parts: Free of burrs and sharp corners and edges.
- E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- G. Diffusers and Globes:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
    - b. UV stabilized.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - 1. Label shall include the following lamp and ballast characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    - d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
    - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    - f. CCT and CRI for all luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. General Requirements for Electronic Ballasts:
  - 1. Comply with UL 935 and with ANSI C82.11.
  - 2. Designed for type and quantity of lamps served.
  - 3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
  - 4. Sound Rating: Class A.
  - 5. Total Harmonic Distortion Rating: Less than 10 percent.
  - 6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
  - 7. Operating Frequency: 42 kHz or higher.
  - 8. Lamp Current Crest Factor: 1.7 or less.

9. BF: 0.88 or higher.
10. Power Factor: 0.95 or higher.

B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

#### 2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

#### 2.5 DRIVERS FOR LED FIXTURES

A. Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:

1. Rated for 50,000 hours of life, unless otherwise noted.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: 20 percent or less.
4. Current Crest Factor: 1.5 or less.
5. 0-10V Dimming Standard (Step Dimming does not qualify).

#### 2.6 EMERGENCY POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate fluorescent lamp(s) or LEDs continuously at an output of 1400 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate lamp or LEDs continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
  - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.



2.7 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Photoluminescent Exit Signs:
  - 1. Description:
    - a. Self-contained, not requiring external power supply, absorbing and storing energy from ambient light and natural sunlight.
    - b. Non-toxic, non-radioactive.
    - c. Free from vinyl and polyvinyl chloride compounds.
    - d. High-visibility green illumination.
    - e. UL approved for use in interior or exterior locations.
    - f. UL 746c (By ETL, Impact Test) approved for Floor Proximity
    - g. Listed to UL 924. Meet NFPA 101 requirements.
    - h. Visible at 50 feet in total darkness.
    - i. Mounting type: Universal - Wall or Ceiling.
    - j. Mounting Aluminum Frame.

2.8 FLUORESCENT LAMPS

- A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 4100 K, and average rated life 20,000 hours unless otherwise indicated.
- B. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4100 K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.
  - 1. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
  - 2. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
  - 3. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).

2.9 LED FIXTURES

- A. Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
- B. Include the following features unless otherwise indicated:
  - 1. Each Luminaire shall consist of an assembly that utilizes edge-lit LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
  - 2. Luminaire optics shall consist of precision formed optical assembly with positively retained high grade acrylic lenses using laser precise micro-prism patterns to provide directional distribution.
  - 3. Each luminaire shall be rated for a minimum operational life of 60,000 hours utilizing a minimum ambient temperature of (25°C).
  - 4. Light Emitting Diodes tested under LM-80 Standards for a minimum of 12,000 hours.
  - 5. Color Rendering Index (CRI) of 82 at a minimum (85 Typical).
  - 6. Color temperature 3500 K, unless otherwise indicated.
  - 7. Rated lumen maintenance at 84% lumen output for 60,000 hours, unless otherwise indicated.
  - 8. Fixture efficacy of 92 Lumens/Watt, minimum.
  - 9. Fixture depth shall be no greater than 4.75"
  - 10. 5 year luminaire warranty, minimum.
  - 11. Photometry must comply with IESNA LM-79.
  - 12. Luminaires shall be Design Lights Consortium Qualified.
  - 13. The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.
  - 14. Luminaire shall be constructed such that driver may be replaced or repaired without the replacement of the whole fixture.
  - 15. Luminaires shall be UL 1598 and UL 2043 listed.
- C. Technical Requirements
  - 1. The luminaire shall not consume power in the off state.
  - 2. Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
  - 3. Power Factor: The luminaire shall have a power factor of 0.9 or greater.

4. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.
5. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

D. Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
2. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
3. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
4. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

2.10 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- B. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- C. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- E. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- F. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Lighting fixtures:
  1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Lay-in Ceiling Lighting Fixture Supports: Use grid as a support element.
  1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
  2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
  4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- D. Suspended Lighting Fixture Support:
  1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
  4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Identify light fixtures that are fed by an emergency generator with a label stating "EMERGENCY SERVICE". Place label on the ballast near the wire terminations.

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to emergency power and retransfer to normal.

3.4 STARTUP SERVICE

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

END OF SECTION

**SECTION 28 31 11**

**DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM**

**PART 1 - GENERAL**

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders.
7. Remote annunciator.
8. Addressable interface device.
9. Digital alarm communicator transmitter.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
  - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
  - b. Show field wiring required for HVAC unit shutdown on alarm.
  - c. Locate detectors according to manufacturer's written recommendations.
12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:
  - a. Trained and certified by manufacturer in fire-alarm system design.
  - b. NICET-certified, fire-alarm technician; Level III minimum.
  - c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.
- C. Sample warranty.

### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
  1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:
    - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    - c. Complete wiring diagrams showing connections between all devices and equipment.
    - d. Riser diagram.
    - e. Record copy of site-specific software.
    - f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
      - 1) Equipment tested.
      - 2) Frequency of testing of installed components.
      - 3) Frequency of inspection of installed components.
      - 4) Requirements and recommendations related to results of maintenance.
      - 5) Manufacturer's user training manuals.
    - g. Manufacturer's required maintenance related to system warranty requirements.
    - h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.
  - B. Software and Firmware Operational Documentation:
    1. Software operating and upgrade manuals.
    2. Program Software Backup: On magnetic media or compact disk, complete with data files.
    3. Device address list.
    4. Printout of software application and graphic screens.

### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

### 1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
  1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
  2. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.
- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Duct smoke detectors.
  - 5. Carbon monoxide detectors.
  - 6. Automatic sprinkler system water flow.
  - 7. Fire-extinguishing system operation.
  - 8. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:
  - 1. Continuously operate alarm notification appliances.
  - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
  - 3. Transmit an alarm signal to the remote alarm receiving station.
  - 4. Unlock electric door locks in designated egress paths.
  - 5. Release fire and smoke doors held open by magnetic door holders.
  - 6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
  - 7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
  - 8. Activate preaction system.
  - 9. Recall elevators to primary or alternate recall floors.
  - 10. Activate elevator power shunt trip.
  - 11. Activate emergency lighting control.
  - 12. Activate emergency shutoffs for gas and fuel supplies.
  - 13. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
  - 1. Valve supervisory switch.
  - 2. Elevator shunt-trip supervision.
  - 3. Loss of communication with any panel on the network.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
  - 1. Open circuits, shorts, and grounds in designated circuits.
  - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  - 3. Loss of communication with any addressable sensor, input module, relay, control module, or remote annunciator.
  - 4. Loss of primary power at fire-alarm control unit.
  - 5. Ground or a single break in internal circuits of fire-alarm control unit.
  - 6. Abnormal ac voltage at fire-alarm control unit.
  - 7. Break in standby battery circuitry.
  - 8. Failure of battery charging.
  - 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
- E. System Supervisory Signal Actions:
  - 1. Initiate notification appliances.

2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

### 2.3 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Fire-Lite Alarms.
  2. GAMEWELL.
  3. GE UTC Fire & Security; A United Technologies Company.
  4. Notifier.
  5. Siemens Industry, Inc.; Fire Safety Division.
  6. Silent Knight.
  7. SimplexGrinnell LP.
- B. General Requirements for Fire-Alarm Control Unit:
  1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
  2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
  3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
  1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
  2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
  1. Pathway Class Designations: NFPA 72, Class B.
  2. Pathway Survivability: Level 0.
- E. Notification-Appliance Circuit:
  1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
  2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
  3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- F. Elevator Recall:
  1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
    - a. Elevator lobby detectors except the lobby detector on the designated floor.
    - b. Smoke detector in elevator machine room.
    - c. Smoke detectors in elevator hoistway.
  2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
  3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
    - a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.
- G. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.
- H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

- I. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.
  - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

#### 2.4 MANUAL FIRE-ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Fire-Lite Alarms.
  - 2. GAMEWELL.
  - 3. GE UTC Fire & Security; A United Technologies Company.
  - 4. Notifier.
  - 5. Siemens Industry, Inc.; Fire Safety Division.
  - 6. Silent Knight.
  - 7. SimplexGrinnell LP.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.
  - 1. Single-action mechanism, breaking-glass or plastic-rod type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  - 2. Station Reset: Key- or wrench-operated switch.

#### 2.5 SYSTEM SMOKE DETECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Fire-Lite Alarms.
  - 2. GAMEWELL.
  - 3. GE UTC Fire & Security; A United Technologies Company.
  - 4. Notifier.
  - 5. Siemens Industry, Inc.; Fire Safety Division.
  - 6. Silent Knight.
  - 7. SimplexGrinnell LP.
- B. General Requirements for System Smoke Detectors:
  - 1. Comply with UL 268; operating at 24-V dc, nominal.
  - 2. Detectors shall be four-wire type.
  - 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
  - 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  - 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  - 6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
  - 7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
    - b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
    - c. Multiple levels of detection sensitivity for each sensor.
    - d. Sensitivity levels based on time of day.



- C. Photoelectric Smoke Detectors:
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).
  
- D. Ionization Smoke Detector:
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).
  
- E. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
  - 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).
  
  - 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
  - 4. Each sensor shall have multiple levels of detection sensitivity.
  - 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
  - 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

## 2.6 CARBON MONOXIDE DETECTORS

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
  - 1. Mounting: Adapter plate for outlet box mounting.
  - 2. Testable by introducing test carbon monoxide into the sensing cell.
  - 3. Detector shall provide alarm contacts and trouble contacts.
  - 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
  - 5. Comply with UL 2075.
  - 6. Locate, mount, and wire according to manufacturer's written instructions.
  - 7. Provide means for addressable connection to fire-alarm system.
  - 8. Test button simulates an alarm condition.

## 2.7 HEAT DETECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Fire-Lite Alarms.
  - 2. GAMEWELL.
  - 3. GE UTC Fire & Security; A United Technologies Company.
  - 4. Notifier.
  - 5. Siemens Industry, Inc.; Fire Safety Division.
  - 6. Silent Knight.
  - 7. SimplexGrinnell LP.

- B. General Requirements for Heat Detectors: Comply with UL 521.
  - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- C. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.
  - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature.
  - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.8 NOTIFICATION APPLIANCES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Wheelock.
  - 2. GE UTC Fire & Security; A United Technologies Company.
  - 3. Gentex Corporation.
  - 4. Siemens Industry, Inc.; Fire Safety Division.
  - 5. SimplexGrinnell LP.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
  - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Chimes: Vibrating type.
- D. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464.
- E. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
  - 1. Mounting: Wall mounted unless otherwise indicated.
  - 2. Flashing shall be in a temporal pattern, synchronized with other units.
  - 3. Strobe Leads: Factory connected to screw terminals.
  - 4. Mounting Faceplate: Factory finished, red.

## 2.9 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
  - 1. Electromagnets: Require no more than 3 W to develop 25-lbf holding force.
  - 2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  - 3. Rating: 24-V ac or dc.
  - 4. Rating: 120-V ac.
- B. Material and Finish: Match door hardware.

## 2.10 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
  - 1. Mounting: Flush cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.11 ADDRESSABLE INTERFACE DEVICE

- A. General:
  - 1. Include address-setting means on the module.
  - 2. Store an internal identifying code for control panel use to identify the module type.
  - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.
  - 1. Allow the control panel to switch the relay contacts on command.
  - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
  - 1. Operate notification devices.
  - 2. Operate solenoids for use in sprinkler service.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
  - 1. Verification that both telephone lines are available.
  - 2. Programming device.
  - 3. LED display.
  - 4. Manual test report function and manual transmission clear indication.
  - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
  - 1. Address of the alarm-initiating device.
  - 2. Address of the supervisory signal.
  - 3. Address of the trouble-initiating device.
  - 4. Loss of ac supply.
  - 5. Loss of power.
  - 6. Low battery.
  - 7. Abnormal test signal.
  - 8. Communication bus failure.
- E. Secondary Power: Integral rechargeable battery and automatic charger.
- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

**PART 3 - EXECUTION**

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

- C. Manual Fire-Alarm Boxes:
  - 1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
  - 2. Mount manual fire-alarm box on a background of a contrasting color.
  - 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.
- E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
- F. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- G. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.
- H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- I. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

### 3.2 PATHWAYS

- A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
  - 1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
- B. Pathways shall be installed in EMT.
- C. Exposed EMT shall be painted red enamel.

### 3.3 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Smoke dampers in air ducts of designated HVAC duct systems.
  - 2. Magnetically held-open doors.
  - 3. Electronically locked doors and access gates.
  - 4. Alarm-initiating connection to elevator recall system and components.
  - 5. Alarm-initiating connection to activate emergency lighting control.
  - 6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
  - 7. Supervisory connections at valve supervisory switches.
  - 8. Supervisory connections at elevator shunt-trip breaker.
  - 9. Supervisory connections at fire-extinguisher locations.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter.
    - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
  - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
  - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
  - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- D. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
  - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

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The General Contractor shall be required to compare this Table of Contents with the bound Project Manual for legibility, omission or inclusion of any part of any section listed herein. It shall be the General Contractor's responsibility to request, in writing, clarification from the office of the Architect. Clarifications shall be addressed by addenda to all who are registered with the Architect as having received Bidding documents. All requests for clarification shall be received seven days prior to the date set for the receipt of Bids.

The General Contractor and Subcontractors shall review other sections of work applicable to their work and ascertain requirements in other section applicable to their work. Each shall be held responsible for coordination and inclusion of the work indicated as if it were in the particular subcontractor's section. All subcontractors, suppliers, etc. shall be responsible for knowing what information is given on all sheets of the plans and specifications concerning his particular work.

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